Engineering Library

APR 21 1927

The Engineer.

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VOL. CXLIII.—No. 3717] LONDON: FRIDAY EVENING, APRIL 8, 1927 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Assistant Engineers (4) REQUIRED for the NIGERIAN GOVERNMENT RAILWAY (Survey) for a tour of 12 to 18 months, with possible extension. Free passages and a commuted bush, travelling and detention allowance of £9 a month whilst on duty in the Colony. Camp equipment provided. Outfit allowance of £60 on first appointment. Liberal leave on full salary. Salary £480 for the first three years of service, then £510, rising by annual increments to £920 a year. Candidates must have passed examination to qualify for A.M.I.C.E. or hold equivalent professional qualifications, and have had experience on railway survey, preferably location.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, mentioning this paper and quoting M/15135. 5167

Assistant Engineers (13) REQUIRED for the PUBLIC WORKS DEPARTMENT of the FEDERATED MALAY STATES for four years' service, after which, subject to satisfactory service, the officers appointed will be eligible for confirmation in the permanent and pensionable establishment. It is probable that the number of permanent appointments will be sufficient for those officers whose services have been entirely satisfactory, but no absolute guarantee can be given. If at the end of four years' service an officer's services have been entirely satisfactory and he is not offered or declines further employment, he will be paid a bonus of 2850 dollars. Salary 400 dollars a month, rising to 800 dollars by annual increments of 25 dollars, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax at present imposed by the Federated Malay States Government. Free passages provided. Candidates, age 23 to 26, preferably unmarried, must have received a good theoretical training, preferably at a University or College recognised by the Institution of Civil Engineers and possess a Civil Engineering Degree or obtained such other diplomas or distinction in engineering as the Secretary of State may decide in any particular case, or have completed articles with a civil engineer of good standing, and have passed the examination for Associate Membership of the Institution of Civil Engineers. In addition, candidates must have had at least one year's practical experience of civil engineering under a qualified engineer.—Apply at once by letter, giving brief details of qualifications and experience and stating age and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting clearly at the head of application M/15224. 5219

Civil Service Commission. FORTHCOMING EXAMINATION. PROBATIONARY INSPECTORS in the Engineering Department of the Post Office (17-20, with extension for service in H.M. Forces).—Regulations and particulars are obtainable from the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1, together with the form on which application must be made. The latest date for the receipt of application forms is 28th July. 5168

The Government of BIHAR and ORISSA REQUIRE the SERVICES of an EXECUTIVE ENGINEER for the PUBLIC HEALTH DEPARTMENT (ENGINEERING BRANCH). Candidates must have had regular training as Civil Engineers and be either Associate Members of the Institution of Civil Engineers or hold equivalent professional qualifications. Seven years' good practical experience in England of the design and execution of waterworks and drainage is essential, and a general knowledge of mechanical and elementary electrical engineering is advantageous. Age 30 to 40 years.

Five years' agreement. Pay in accordance with an age scale, e.g., age 30, Rs. 725 a month plus overseas pay, £25 a month; age 40, Rs. 1175 a month plus overseas pay, £30 a month. Free first-class passage to India for self and wife and return passage on satisfactory termination of agreement. Provident Fund. Strict medical examination. (Overseas pay and return passage admissible only to an officer of non-Asiatic domicile.)

Further particulars and forms of application may be obtained (on request by post card) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 14th April, 1927. 5074

Crystal Palace School of Practical Engineering.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.
Students admitted at beginning of any term. 5189

University of Liverpool.
FACULTY OF ENGINEERING.

DEAN: Professor C. O. BANNISTER, M. Eng., Assoc. R.S.M., F.I.C., M. Inst. M.M.

The University awards the Degrees of B. Eng., M. Eng., D. Eng., Ph.D., and a Certificate and Diploma in Engineering.

Degree Candidates must pass an approved Matriculation Examination. Certificate Candidates must submit evidence of having received a good general education. Diploma Candidates must possess the Certificate in Engineering.

The Courses are designed for students desiring to qualify as MECHANICAL, ELECTRICAL, CIVIL or MARINE ENGINEERS, as NAVAL ARCHITECTS and METALLURGISTS or METALLURGICAL ENGINEERS. The Courses cover the subjects of examination for Associate Membership of the Institutions of Civil, Mechanical, and Electrical Engineers. The Institutions named, subject to certain conditions, accept the Degree of B. Eng. in lieu of part, and in some cases the whole, of the examinations for Associate Membership. The various Departments are housed in commodious and well-equipped buildings, and provide ample facilities for research.

A prospectus of the Faculty, giving particulars of Courses and a large number of Entrance and Post-graduate Scholarships, may be had on application to the undersigned.

EDWARD CAREY, Registrar.
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The Engineer

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PUBLIC NOTICES

The Institution of Structural Engineers.
BRENFORCE TRAVELLING SCHOLARSHIP.
VALUE £300.

The "Brenforce Travelling Scholarship" will be awarded triennially, including 1927. The Scholarship is awarded "with the object of encouraging the esthetic design and artistic development in England of buildings in concrete and reinforced concrete." The competition will consist of a problem in design, conducted on Beaux Arts methods (i.e., a preliminary twelve-hour sketch design, of which a copy is lodged, followed by finished final designs from the sketch, for which 28 days is allowed). Preliminary competition on Saturday, 7th May. Candidates must be members (in any class) of the Institution, between the ages of 21 and 40 years. Winner receives £300 and gold medal. Closing date for entries, Monday, 2nd May. Syllabus and full particulars from the undersigned.

MAURICE G. KIDDY, F.I.S.A.,
Secretary of the Institution.
10, Upper Belgrave-street, S.W. 1,
21st March, 1927. 5059

County of London.
SUPPLY OF TRAMWAY RAILS, 1927-28.

The London County Council invites TENDERS for the SUPPLY and DELIVERY in London of:—

(a) About 2800 TONS of STANDARD STEEL GIRDER TRAMWAY TRACK RAILS, FISH-PLATES and FISH-BOLTS, &c.; also

(b) About 480 TONS of CONDUCTOR RAILS, which will form the subject of a separate contract.

Persons desiring to Tender may obtain the specifications, bills of quantities, forms of Tender, drawings, &c., on application to the Chief Engineer of the Council at the Old County Hall, Spring-gardens, S.W. 1, on and after Monday, 11th April, 1927, upon payment of the sum of £2 in each case, by cheque or draft to the order of the London County Council. This amount will be returnable only if a bona fide Tender is submitted and not withdrawn. Full particulars for the work and conditions of contract may be seen at the Old County Hall before payment of this fee.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 9th May, 1927, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
5169 Clerk of the London County Council.

PUBLIC NOTICES

Bombay, Baroda and Central India Railway Company.

The Directors are prepared to receive up to Noon on Friday, 22nd April, 1927, TENDERS for the SUPPLY of:—

LAMPS and MISCELLANEOUS GLASS.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France, S.W. 1,
4th April, 1927. 5175

Metropolitan Water Board.
TENDERS FOR THE SUPPLY OF STORES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES, &c., for the periods of 6 and 12 months, commencing 1st June, 1927:—

Tender No.
1. Bricks, Fire-bricks, Cement, &c.
8. Iron and Steel.
9. Bolts and Nuts, Screws, Files, Shovels, Steam Tubes, &c.
11. Repair of Meters.
12. Fuel Oil, Oils (Lubricating), Kerosene, Motor Spirit, Greases, Tallow, &c.
19. Small Iron, Brass, Gun-metal, and other Castings.
20. G.M. Stop Cocks and Ferrules, Outlets and Caps for Fire Hydrants.
22. Timber.
23. Maintenance of Weighing Machines.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer on and after Monday, 11th April, 1927, by personal application at the Board's offices (Room 156) or upon forwarding a stamped addressed brief envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board, and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Friday, 29th April, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
New River Head,
173, Rosebery-avenue, E.C. 1,
4th April, 1927. 5215

PUBLIC NOTICES

Metropolitan Water Board.
MAIN—ALBERT-ROAD TO BRECKNOCK-ROAD.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of approximately 2909 LINEAL YARDS of 36in. diameter CAST IRON WATER MAIN and CONNECTIONS, together with CONTINGENT WORKS, from Albert-road in the Metropolitan Borough of St. Pancras, to Brecknock-road, in the Metropolitan Borough of Islington, in the County of London.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after the 20th April, 1927, from the Chief Engineer, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender, accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4.30 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Main, Albert-road to Brecknock-road," must be delivered at the offices of the Board (Room 122) not later than 10 a.m. on Monday, the 9th May, 1927.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
6th April, 1927. 5216

State Electricity Commission OF VICTORIA, AUSTRALIA,
22-32, WILLIAM-STREET, MELBOURNE, AUSTRALIA.

TENDERS are hereby INVITED for the MANUFACTURE, SUPPLY and DELIVERY for the Yallourn Brown Coal Works, Victoria, Australia, of 15,000 K.W. STEAM GENERATOR and ACCESSORIES in accordance with Specification No. 27/33.

Copies of Tender form, specification, &c., will be available upon application to:—
The Agent General for Victoria,
Victoria House, The Strand,
London, England.

CHARGE.—£1 1s. for three copies of Tender form, conditions of contract and specification complete. This charge will be returned in the event of a bona fide Tender being received. Extra copies 10s. each, not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of 1 per cent. of total Tender price is to be lodged with Tender with a maximum of £100.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered at the office of the Commission, Melbourne, not later than 5th July, 1927.

The Commission does not bind itself to accept the lowest or any Tender.

R. LIDDELOW,
5176 Secretary.

Madras and Southern Mahratta Railway.
ONE ASSISTANT ELECTRICAL ENGINEER.

REQUIRED for service on the Company's Railway in India, ONE ASSISTANT ELECTRICAL ENGINEER, 24 to 30 years of age, and preferably unmarried, who must have a thorough knowledge of Telegraph and Telephone Work as applied to railway working. He should have experience in Lock-and-Block Track Circuiting, Token Instruments, Automatic and Manual Telephone Exchange, and Control Circuits, Wheatstone and Duplex Telegraphs. Additional qualification would be some experience of line construction and maintenance and the laying of telegraph cables.

TERMS.—A first-class free passage to India and return on satisfactory termination of services, and a three years' agreement, which may be continued if agreeable to both parties.

SALARY.—Rupees 525 to 725 per calendar month, according to age and experience.

The selected candidates will be required to pass a strict medical examination before appointment.

Applications (by letter only), giving full particulars of general and technical education, honours gained (if any), age, whether unmarried, and details of practical experience, in chronological order (with dates), together with COPIES ONLY of testimonials, must be addressed as below not later than 29th April, 1927.

THE SECRETARY,
Madras and Southern Mahratta Railway Co., Ltd.,
25, Buckingham Palace-road,
Westminster, London, S.W. 1.
5th April, 1927. 5221

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Auckland Harbour Board, New Zealand.

TENDERS are INVITED for the CONSTRUCTION, SUPPLY, and DELIVERY on wharf, Auckland, all charges paid, of ONE 3-TON ELECTRIC TRAVELLING JIB CRANE. Tenders to be received in Auckland not later than 7th June, 1927. Copies of specifications and Tender form may be obtained on payment of One Guinea from the Board's London Agent,

CHARLES R. BUTTERS,
96, Charterhouse Chambers, London, E.C. 1.
Telephone No., Clerkenwell 0160. 5217

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a STRUCTURAL ENGINEER for a British Firm in India, to assist the director, who has under his control the drawing-office and estimating departments, structural steel workshops, foundry and machine shops. Should have A.M.I.C.E. or equivalent qualifications; must be a good organiser and have had thorough technical training and practical experience. Age 30 to 35. Good salary and prospects to a suitable man.—Address, P3045, The Engineer Office. P3045 A

WANTED, an ASSISTANT to GENERAL MANAGER of Group of Limestone Quarries; applicant must have good technical training and practical experience. Age about 30.—Address, 5226, The Engineer Office. 5226 A

WANTED, ASSISTANT, Age About 25-30, to Help on Sales side in London office of old-established Firm of Engineers. Smart appearance and some technical knowledge essential.—Address, giving full particulars of education, experience, and salary required, P3024, The Engineer Office. P3024 A

WANTED, Experienced MAN, to Take Complete Charge of Electric Furnace for the manufacture of Steel Castings; chemist kept. Give experience, salary required.—Address, 5212, The Engineer Office. 5212 A

WANTED, Experienced WORKS CHEMIST and an ASSISTANT, to Take Charge of Mixed Feed and Gas-fired Lime Kilns; must have sound general and first-class technical education.—Address, 5227, The Engineer Office. 5227 A

WANTED for an Oxygen Business in England, ENGINEER, with experience of modern Oxygen Producing Plants. Knowledge in the production of Dissolved Acetylene also desirable.—Address, P3051, The Engineer Office. P3051 A

WANTED for MIDLAND DISTRICT, First-class CONSTRUCTIONAL ENGINEER, used to Colliery, Bridge, and general constructional work. Must be capable of taking out stresses, and taking charge of all office work, including estimating, costing, and general designing. Only practical and energetic men over 30 years of age need apply, giving full references and details of career which will be treated as confidential. State salary, and when at liberty.—Address, 5195, The Engineer Office. 5195 A

WANTED, REPRESENTATIVE of Gentlemanly appearance and address with connection in Home Counties to call upon prospective clients and secure orders for Factory Construction, Reinforced Concrete and General Building Work. Applicant must have knowledge of the business. Car provided and commission paid. State age, salary required, and experience.—Address, P3052, The Engineer Office. P3052 A

WANTED, YOUNG MAN, Qualified, by Technical training and practical experience, as Principal Assistant to Director in the design and inspection of small machines and instruments, and in experimental work connected therewith.—State qualifications fully to TAYLOR, TAYLOR and HOBSON, Ltd., Stoughton-street Works, Leicester. 5211 A

AERONAUTICAL DESIGNER WANTED with thorough and detailed practical experience in Design and Production. Good salary to suitable man. Only first-class men need apply. State age, salary and experience.—Address, P3031, The Engineer Office. P3031 A

CEMENT WORKS ENGINEER REQD., India; exp. Smidth's Rotary Plant and Erection Work ess. Single. 28/35. Rupees 750 p.m.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No Preliminary Fee. 5206 A

DRAWING-OFFICE MATERIAL.—Well-established Firm with Branch in Newcastle, REQUIRES a REPRESENTATIVE for the North-East Coast area. Applicant with experience of Drawing-office practice would be considered.—Address, P3037, The Engineer Office. P3037 A

ENGINEER, Competent and Qualified, Take Charge, to do running repairs, Electrical, Mechanical, Hydraulic Machinery at waterside warehouses, London; Cranes, Lifts, Conveyors, Elevators, Pumps, &c. Send copies of testimonials, state experience, salary required.—Address, P3061, The Engineer Office. P3061 A

ENGINEER-IN-CHIEF WANTED by One of the largest Electric Supply Companies in the kingdom, to Take Control of the Engineering Section of the undertaking.

Applicants must have held positions of leading and superior responsibility and have had extensive experience of the problems involved in supply over wide areas, and in the design, construction, and operation of modern Power Stations, Super-tension Transmission, and Distribution to the general body of consumers—bulk and otherwise.

The successful candidate will be required to devote his whole time to the duties of the office.

Applications, accompanied by copies of testimonials, to be sent to "ELECTRIC," c/o Street's, 6, Gracechurch-street, E.C. 3. 5210 A

ENGINEERING SALESMAN.—Opening for Young energetic man. Public schoolboy with engineering training and liking for sales side. Subsistence salary with payment on results.—Address replies, detailing full personal particulars and experience, 5208, The Engineer Office. 5208 A

FACTORY ASSISTANT REQUIRED in Malaya. Essential qualifications, four or five years' general experience in a Rubber Factory and a sound knowledge of the Manufacture of Rubber Goods for sale on the European markets. Chemical knowledge not necessary. British, well educated, age 23/26, single. Commencing salary £420 per annum on a progressive scale. Four-year agreement; outfit allowance and passage paid.—Reply, giving full details, to Box 214, c.o. Judd's, 47, Gresham-st., London, E.C. 2. 5220 A

MECHANICAL ENGINEER, with Fair Knowledge of French, experienced SALESMAN for Turbo-machinery (pumps, fans, compressors, steam turbines), WANTED by important French Firm for London Agency.—Write to Mr. RIEDER, 50, Rue Fabert, Paris (7o). P3053 A

METALLURGIST.—HANS RENOLD, Ltd., Desire to THANK all APPLICANTS for POSITION, and wish to state that the VACANCY has now been FILLED. 5173 A

PRODUCTION ENGINEER REQD., Provinces; exp. Production Oil Engines, Compressors and Steam Turbine Work ess. Good sal. to good man. Aged 28/38.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No Preliminary Fee. 5207 A

REPRESENTATIVES REQUIRED by Well-known Firm in the Midlands, manufacturing Electric Cranes and Lifts, for Manchester and District, Belfast and Dublin.—Address, stating experience and terms, 5198, The Engineer Office. 5198 A

SITUATIONS OPEN (continued)

REPRESENTATIVE, with Engineering Training, to call on Waterworks Engineers and Contractors; personal connection essential.—Write in strict confidence, with full particulars, age, experience, and salary expected.—Address, 5214, The Engineer Office. 5214 A

WANTED, DRAUGHTSMAN, Thoroughly Experienced in the design of Cable Machinery, Armouring Machines, &c.—Address, giving all particulars of recent employment, which will be treated in strictest confidence, and salary required, 5213, The Engineer Office. 5213 A

WANTED IMMEDIATELY, in the Midlands, DRAUGHTSMAN, experienced in detail drawings for all classes of Reinforced Concrete Structures. —Full particulars and salary required to P3040, The Engineer Office. P3040 A

ASSISTANT DRAUGHTSMAN WANTED Promptly in Engineering Works, Eastern Counties, age 25 to 30, with good general mechanical engineering experience, preferably one familiar with and competent to design throughout Medium size Stationary and Portable Steam Engines.—Address, stating age, experience, salary required, and when disengaged, 5183, The Engineer Office. 5183 A

DRAUGHTSMAN, Experienced, WANTED; Essential have thorough knowledge of Structures, Boiler-house Lay-outs, Coal Handling and Pulverised Fuel Installations.—Write, stating age, experience and salary required, Box 860, Sell's Advertising Offices, Fleet-street, E.C. 4. 5201 A

DRAUGHTSMAN REQUIRED, Experience in the design and detail of Coal, Coke and Materials Handling Plant.—Applications, giving full details of experience, age, and salary required, to be addressed to THE CHIEF ENGINEER, The Gas Light and Coke Company, Horseferry-road, S.W. 1. 5196 A

DRAUGHTSMAN REQUIRED Temporarily. One experienced in Mechanical Detail Work Design on Compressors essential.—Address, stating age, experience and salary required, 5228, The Engineer Office. 5228 A

DRAUGHTSMAN, Thoroughly Experienced, WANTED, with knowledge of Details and Lay-out of Mining and Milling Machinery and Structures.—Apply, stating age, experience and salary required, FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 5200 A

DRAUGHTSMAN WANTED, Age About 30, capable of Designing Modern Coal and Coke Elevators and Conveyors, and with good experience in General Mechanical Details. State full particulars and salary required.—Address, 5202, The Engineer Office. 5202 A

DRAUGHTSMAN WANTED for London; Experience in designing and details Elevator, Conveying Plant. Please send full particulars, age, experience, salary required.—Address, P3048, The Engineer Office. P3048 A

DRAUGHTSMEN WANTED IMMEDIATELY by Firm in the Manchester district, with sound experience of Turbo-alternator and Condensing Plant Lay-out. Applicants must state age, experience, and salary required.—Address, 5174, The Engineer Office. 5174 A

DRAUGHTSMAN, with Experience in Designing and estimating quantities for large Conveying Plants, WANTED for Engineering Works in North Midlands.—Address, 5188, The Engineer Office. 5188 A

FIRST-CLASS DRAUGHTSMAN WANTED for Tender Designs of Lock Gates and similar apparatus.—Apply, as below, stating age, experience, and salary required, Box No. 3967, c/o Brown's, 39, Tothill-street, S.W. 1. 5192 A

JUNIOR DRAUGHTSMAN REQUIRED by Well-known Midland Firm of Electric Crane and Lift Manufacturers.—Address, stating age, experience, and salary, 5186, The Engineer Office. 5186 A

MESSRS. NEWTON, CHAMBERS and CO. Ltd., Thorncliffe Ironworks, near Sheffield, REQUIRE the SERVICES of a responsible DRAUGHTSMAN with experience in Gas and Chemical Works Plant.

Applicants are requested to state their qualifications, age, experience, salary required, and date duties could be began after appointment. Company's house available for successful applicant. 5107 A

REQUIRED, as GENERAL ASSISTANT to the Manager of a Small Water Company near London, a YOUNG MAN with some training in both technical and management sides of a water undertaking. Must be prepared to assist in clerical duties.—Address, with testimonials, stating age, experience and salary required, 5171, The Engineer Office. 5171 A

STRUCTURAL DESIGNER REQD., London; must have good exp. Tank Work and Detailed Structures; excellent opening for really good man. Start £416. Age 27/34.—Apply, LAURIE'S, Employment Specialists, 28, Basinghall-st., E.C. 2. No Preliminary Fee. 5205A

STRUCTURAL DRAUGHTSMAN REQUIRED by British Firm in India. Must have had good technical training, be able to work out stresses, prepare designs, estimates and detail drawings of Roof, Bridge and General Structural Steel Work. Must be a bachelor, age 22 to 27.—Address, stating age and particulars of experience, P3046, The Engineer Office. P3046 A

ENGINEER'S FOREMAN WANTED for Small Factory in South London; must have thorough knowledge of Sheet Metal Trade and be able to make own tools, excellent and progressive opening for man able to increase output on piecework or bonus system. State age and full experience.—Address, P3063, The Engineer Office. P3063 A

FIRST-CLASS IRONFOUNDRY FOREMAN REQUIRED; must be familiar with modern methods of economical production. Capacity 20 tons per week of gear blanks, gear cases and machine tool castings.—Apply in writing, stating age, experience, and salary required, to DAVID BROWN and SONS (HUDDFD.), Ltd., Lockwood, Huddersfield. 5172 A

FOREMAN WANTED with General Experience in Riveted Constructional Work, Circular Tanks, Piping, Stills, &c.—Address, P3029, The Engineer Office. P3029 A

PATTERNMAKERS.—Permanency for Capable Men. District rate.—Apply, P. J. SMITH, 2 and 2a, Wynyatt-street, Goswell-road, E.C. 1. 5151 A

SITUATIONS WANTED

APPRENTICED ENGINEER SEEKS CHANGE, Age 29, single. Experience motor and general engineering, experimental work; capable charge hand or foreman.—Apply, A. G. HOVERS, 112, Croydon-road, Erdington, Birmingham. P2993 B

BUYER, Well Versed in Engineering and Refrigeration Markets, SEEKS similar POSITION, or Merchants' Office, or Salesman.—Address, P3038, The Engineer Office. P3038 B

CHIEF of PLANNING and RATE-FIXING DEPT. DESIRES CHANGE. General engineering and motor car experience in important firms in the Midlands, estimating and jig and tool design; has held important staff positions.—Address, P3057, The Engineer Office. P3057 B

CIVIL ENGINEER (23), University Graduate (Hons.), 12 months' experience on large waterworks scheme, excellent references, DESIRES POST, home or abroad.—Address, P3049, The Engineer Office. P3049 B

SITUATIONS WANTED (continued)

CIVIL ENGINEER, University and Works trained, extensive technical and practical experience of general engineering work, building construction, reinforced concrete, hydraulic works construction, piling, roads, railways, surveying, D.O., &c. Works management installation and maintenance of plant, &c. General commercial experience, shortly disengaged, SEEKS responsible POST. Home or abroad; moderate salary.—Address, P3041, The Engineer Office. P3041 B

CIVIL ENGINEER OPEN to UNDERTAKE SETTING-OUT of WORKS. Contracts carried through by periodic visits. Water, Railway, Sewage, &c. &c.—Address, P3058, The Engineer Office. P3058 B

CIVIL ENGINEER, 16 Years' Experience, Contractors, DESIRES APPOINTMENT. London preferred. Free shortly.—Address, P3054, The Engineer Office. P3054 B

CIVIL ENGINEER, University Graduate, Surveying, levelling, drawing, and general experience, SEEKS POST. Small salary to start.—Address, P3060, The Engineer Office. P3060 B

ENGINEER (30), Well Educated, Apprenticeship and college training, works and travelling experience, DESIRES to GET in TOUCH with FIRMS which could use his services. Loyal and energetic. Full particulars.—Address, P3059, The Engineer Office. P3059 B

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A Seven-Day Journal

Lifeboat Trials with Flooded Engine-room.

DURING the past week or so some unusually interesting trials were made at Cowes by the Royal National Lifeboat Institution with a new twin-screw lifeboat of the Watson cabin type. The boat is equipped with twin petrol motors of 40 B.H.P. each, which are the first to be built of a new type of engine. The engines were constructed by the Weyburn Engineering Company, Ltd., of Elstead, Surrey, and have cylinders with a bore of 4¼in. and a stroke of 5½in. They operate at a normal speed of 1200 r.p.m., the engine speed being reduced to 600 r.p.m. at the propeller by means of a Burn type gear. Before beginning the trial the engine-room was completely flooded with fresh water, which in weight was equivalent to eighty-three men. With seventeen men on board, or a total equivalent of one hundred men, the boat put to sea and maintained her full engine speed of 1200 r.p.m. for two hours, with the 5½ tons of water in the engine-room washing over and around the motors, and against the bulkheads. After this trial the engine-room was pumped out and the lifeboat again went out in a southerly gale with a very heavy sea running. She was tried out with the sea ahead, on the bow, abeam and astern, and although nothing had been done to her engines since the trial run with the flooded engine-room, she continued to run at full speed under these varying conditions, completing her 8½ hours' endurance trial without a hitch.

Electricity in Warships.

SOME interesting historical information was given in the early part of a paper on "The Applications of Electricity in Warships," read last week before the Institution of Electrical Engineers by Mr. William McClelland. Electricity in the British Navy dates from 1874, when an electrical contrivance was first employed for firing guns, whilst in 1879 an electrical device was used for the discharge of torpedoes from an observing and directing station. The searchlight was the next electrical appliance to establish itself on board ship, a complete installation being fitted in 1876 in H.M.S. Minotaur. In 1881 the first electric lighting installation was fitted on H.M.S. Inflexible. About the beginning of the present century the low pressure of 80 volts was increased to 100 volts, and electricity began to find increasing favour for power purposes as well as for lighting. Power requirements soon made a further increase in the pressure desirable, and after much discussion direct current at a pressure of 220 volts was adopted as a standard for the larger British warships. Probably the years 1904–1906, when the ring main system and the parallel running of dynamos were introduced, may be taken as the beginning of modern electrical development in the British Navy. Since then the applications of electricity have advanced in variety concurrently with those on shore.

Signalling School for the Tube Railways.

As practically the whole of the Metropolitan District Railway and of the tubes of the London Electric Railways Company is protected solely by automatic signalling, the education and training of the men engaged in the installation and maintenance of signalling on those lines are of prime importance. In addition to automatic signals there is the power operation of the points and signals that are coupled to signal-boxes. The railway company has, therefore, provided a signalling school at South Kensington, wherein there is a full-sized length of track, a pair of facing points, an electro-pneumatic interlocking frame, each type of signal, automatic train stop, an illuminated diagram and every detail of signal equipment. Classes for the instruction of signal linesmen, fitters, installers and apprentices are held in the school each Monday and Friday evening, when the men are not only taught the practice of signalling, but are given an opportunity to correct failures—purposely made—which they are likely to meet with. One benefit of the school is that a man employed on a certain section can make himself acquainted with apparatus that is only to be found on some other section or sections. Attendance is purely optional and the men go in their own time. By the courtesy of the Underground authorities we had an opportunity of inspecting the school on Monday last and were impressed with the efforts made to qualify the signal department staff for the important duties that they have to perform.

The Trans-Saharan Railway.

TOWARDS the end of last year three missions were sent from North Africa across the Sahara Desert to the Niger Valley with the object of prospecting a route for the future Trans-Saharan Railway and ascertaining the commercial possibilities of the vast territories watered by the Niger, which would have to provide a huge traffic to make the railway pay. The missions were composed of engineers, agriculturists, commercial men, and financiers. One started from Oran and the others from Algiers and Constantine, the two latter joining at In Salah, and continuing the journey together to Bourem on the Niger, where they met the first mission. The idea of constructing the railway has always been strongly advocated by the military authorities, who regard it as necessary for the transport of native troops to North Africa and France, but it met with considerable scepticism elsewhere on account of the supposed technical difficulties to be encountered in any attempt to cross the Sahara. During the past two or three years the desert has been traversed by motor cars in all directions, and the three missions concluded that there was nothing to prevent the construction of the railway, not even through the more direct Hoggar region, which has always been regarded as offering an insuperable barrier. The routes have been traced out for further survey, and no time will be lost in pushing the scheme forward. It is obvious that the question of maintenance will influence the final decision, and regions liable to severe sand storms will have to be avoided. The railway is regarded as so far indispensable for the commercial development of the Niger Valley that any difficulties are not likely to prevent its construction. In the country watered by the Niger between Upper Volta and the French Sudan several companies are already producing cotton. With the existing irrigation facilities it is claimed that 1,500,000 acres of territory can be made to produce 300,000 tons of raw cotton and 600,000 tons of oleaginous and other vegetable products.

William Beardmore and Co., Ltd.

THE appointment of an advisory committee by the directors of William Beardmore and Co., Ltd., has now been confirmed in a circular recently issued to the holders of the firm's 8 per cent. notes. It is stated in that circular that since the end of the coal strike the works have been well occupied, and that contracts of a profitable nature will keep them moderately well filled for some time to come. The prolonged depression in the shipbuilding, steelmaking and engineering industries has, however, seriously affected the financial resources of the company. The directors, considering that it is to the interest of all holders of the company's shares and securities to appoint an advisory committee, have invited certain experts to investigate the affairs of the company and advise as to the best steps to be taken. The gentlemen mentioned are Mr. F. A. Szarvasy, chairman of the British, Foreign and Colonial Corporation, Ltd.; Sir Gilbert Garnsey, of Price, Waterhouse and Co.; Mr. W. W. Paine, director of Lloyd's Bank, Ltd.; and Mr. P. E. Marmion, director of the Burma Corporation, Ltd.

Scapa Flow Salvage Operations.

IT will be recalled that at the end of September last work was begun by Cox and Danks, Ltd., on the raising of the ex-German battle-cruiser Moltke at Scapa Flow. She lies off the island of Cava, and is sunk in a completely upturned position with a list of 16½ degrees in about 72ft. of water. The salvage method employed—which is now well advanced—involves the use of compressed air to drive the water out of the hull. It is generally similar to that which was successfully adopted in raising the Italian battleship Leonardo da Vinci, which was described and illustrated in our issue of March 18th, 1921. The first operation on the Moltke was to close all holes in the upturned hull, which was done with concrete, no steel patches being used on the hull of the ship. Following the completion of this work two 5ft. diameter air locks were attached at low tide to the skin of the ship, each having an overall length of about 24ft. An air pressure of about 12 lb. per square inch is employed, which has enabled the boiler-rooms to be inspected and the forward bulkhead to be made intact. Work is at present proceeding on the engine-room bulkhead, which should be finished in about ten days' time. In order to assist in the final lifting operation, two of the firm's large floating docks, fitted with winch gear, are being attached to the stern turrets of the ship, and they should together be capable of giving an additional lifting power of 2400 tons. All being well, sufficient air will have been pumped into the hull by about the end of the month, when it is confidently expected that the Moltke will be floated sufficiently to enable her to be towed to the island of Cava for dismantling.

The Prevention of Unemployment.

THERE was issued this week the text of a Bill designed to make provision for the prevention of unemployment in the United Kingdom, Northern Ireland excluded. The Bill bears the names of nine members of the Labour-Socialist Party. It provides for the setting up of a fund to be known as the National Employment and Development Fund, to which contributions are to be made from the Exchequer at the rate of ten million pounds sterling per year. This fund is to be placed at the disposal of a National Employment and Development Board, consisting of the heads of ten specified Government Departments. The Board is to be empowered to make advances from the Fund by way of grant or loan, to Government Departments, local or public authorities, associations of persons or companies. The money so advanced would be expended in the United Kingdom or any other part of the British Empire on any purpose calculated in the opinion of the Board to promote employment, including the better utilisation and development of land, capital undertakings, transport, mines, and electrical undertakings. A clause of the Bill proposes measures for maintaining at an approximately constant level the national aggregate demand for labour by public and private employers. The Board under this clause is to pursue continuous investigation into the nature of and remedies for unemployment, and in conjunction with other Departments is to prepare schemes for the execution of works, these schemes to come into operation at such times as the state of unemployment then prevailing may require. Local authorities are to be required to prepare similar schemes to cover the existence and probabilities of unemployment in their own areas. These local schemes are to be submitted to the Board, and, if approved, must be carried out within a time prescribed by the Board.

The French Coal War.

IN his own words the French Minister of Public Works has announced his intention in the Chamber of Deputies of carrying on "war" against the importation of British coal into France. The Government fully approves the terms of the report of the Comité Central des Houillères de France, which is endeavouring to reduce wages with the object of bringing down coal prices and is hoping to secure special preferential railway rates for the carriage of French fuel to those parts of the country at present supplied with British coal. The production at the French pits is steadily increasing, and every effort will be made to augment still further the output until practically the whole of the home needs are satisfied by the home collieries. It is recognised that there is little chance of competing with British coal in the South of France, but the quantity imported is to be reduced to one-third of what is at present being sent. The first object of the Minister of Public Works was, therefore, to settle the differences between coalowners and miners over the question of wages which threatened a serious complication. In the Nord and the Pas de Calais the men have agreed to a reduction of 2·60f. a day on the highest scale of wages and a proportionate reduction on the others. The owners thereupon quoted down the price of industrial coal by 8 to 12 per cent., and for household coal the drop is much greater. The effect of this cheaper coal is to inspire more confidence in the industrial future on the supposition that it must have the effect of bringing down prices all round. The Minister of Public Works also states that he has succeeded in obtaining from the railway companies, except one, special preferential rates for the carriage of coal from the North of France to the more distant parts of the country. It is hoped in this way to create a demand for all the coal the French collieries can produce. At the same time the Minister expresses his belief that in the forthcoming Tariff Bill the Chamber of Deputies will accept the proposal to impose an import duty on anthracite. This is intended to keep out Welsh anthracite in favour of French substitutes, which are being offered at lower prices under the designation of "English variety" anthracite. It is mostly anthracitic coal from Anzin and elsewhere.

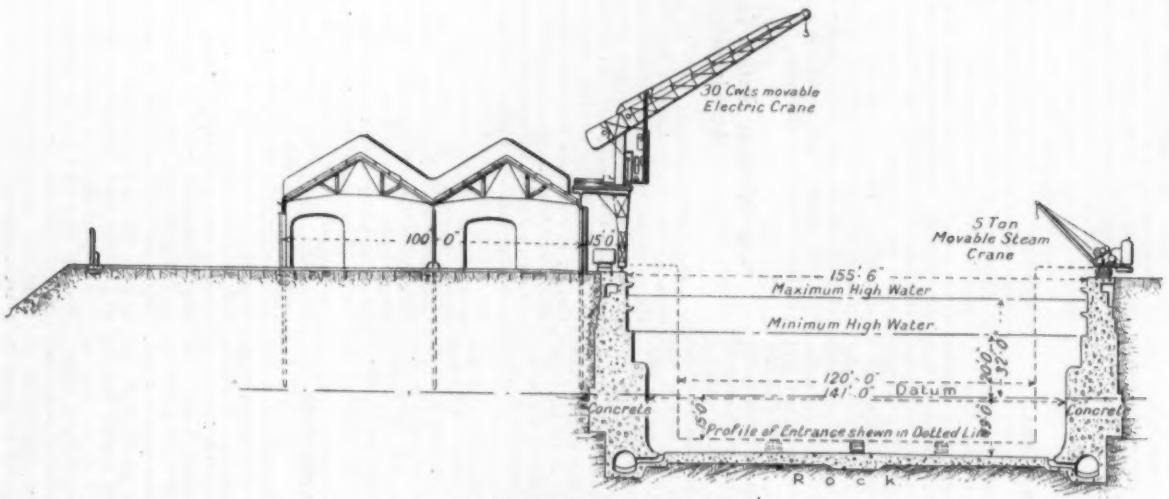
New Wireless Station for Croydon Aerodrome.

AMONG developments now in hand for the reorganisation of the London Air Port at Croydon is the provision of a new wireless station, which is to be erected for the Air Ministry by Marconi's Wireless Telegraph Company, Ltd., to replace the plant that has been in use for the last seven years. When this station is complete Croydon will possess a wireless equipment which will considerably extend its range of communication with other terminal aerodromes and with aeroplanes in flight. The new station will consist of a group of four 3-kilowatt wireless transmitters operated in conjunction with a wireless direction-finding receiver. The transmitters will be capable of telephonic and continuous wave and interrupted continuous wave telegraphic transmission, the wave range being from 800 m. to 2000 m. Independent drive circuits will be incorporated to maintain constancy of frequency and wave length. Energy for the transmitters is to be supplied by a common motor alternator group, the power from which may be switched on to any of the transmitters. The new wireless direction-finding receiver has been specially designed for the work by the Research Department of the Marconi Company and incorporates the latest filtering and amplifying devices. It is arranged so that, if required, two or more circuits can be operated on different wave lengths for the reception of telephony and telegraphy on the same aerials. In order to keep the neighbourhood of the aerodrome as free as possible from obstruction the wireless masts and transmitters are to be erected two or three miles from the Air Port and will be operated by the "remote control" system. It is expected that the new equipment will be in full service before the end of the present season.

DOCK EXTENSIONS AT LIVERPOOL—SECTIONS OF NEW DOCKS AND TRANSIT SHEDS

MR. THOMAS W. NEWELL, M. INST. C.E., LIVERPOOL, ENGINEER

(For description see opposite page)



GLADSTONE GRAVING DOCK
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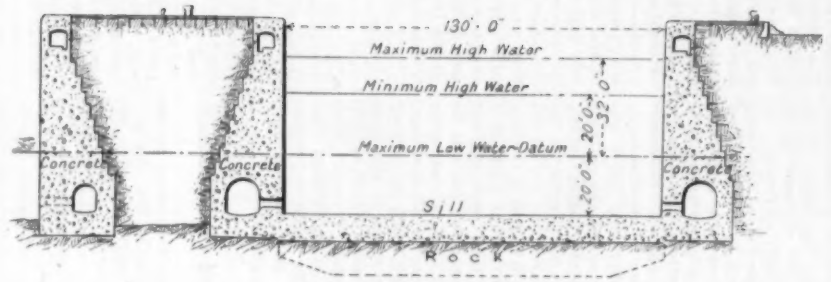

RIVER ENTRANCE LOCK
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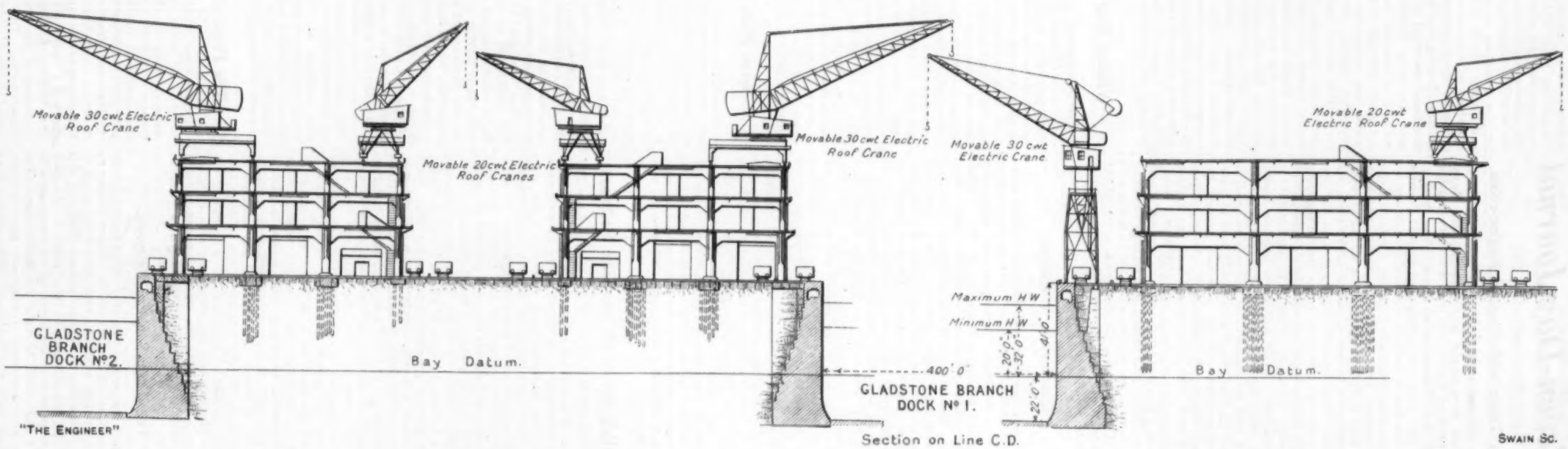

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GLADSTONE DOCKS, LIVERPOOL

MR. THOMAS W. NEWELL, M. INST. C.E., LIVERPOOL, ENGINEER

TURNING BASIN AND BRANCH DOCKS

Dock Extensions at Liverpool.

ALTHOUGH parliamentary powers were obtained by the Mersey Docks and Harbour Board in 1906 for the construction of new docks at the north end of the Board's Liverpool estate, it was not until the Cunard Company decided to build the Aquitania in 1910 that a start was actually made on this great undertaking. It was in order to provide dock accommodation for that famous vessel that the graving dock—the largest in Europe—forming part of the scheme, was put in hand first. The unusual course was adopted of providing one of the quays with transit sheds, so that the dock could be used as either a dry or wet dock. This dock was completed in 1913, or just about twelve months before the outbreak of war, and, needless to state, it proved of inestimable value to the nation during the several following years of war.

The complete scheme, which is now nearing completion—and a plan and sections of which are given herewith and on page 372—includes the Gladstone graving dock, river lock entrance, a vestibule or turning dock, a lock between the existing Hornby Dock, and two branch docks with their storage sheds. The water area involved is 58¼ acres, quayage about three miles, ground covered 13¾ acres, and the gross floor area of the sheds is 55 acres. The graving dock is built to the north of the old Rimrose river wall, which for many years formed the northern boundary of the Board's estate, but which no longer exists. The area formerly enclosed by this wall consists of reclaimed land which was filled up to the Hornby Dock quay level by earth from the excavation for the Langton, Alexandra and Hornby docks.

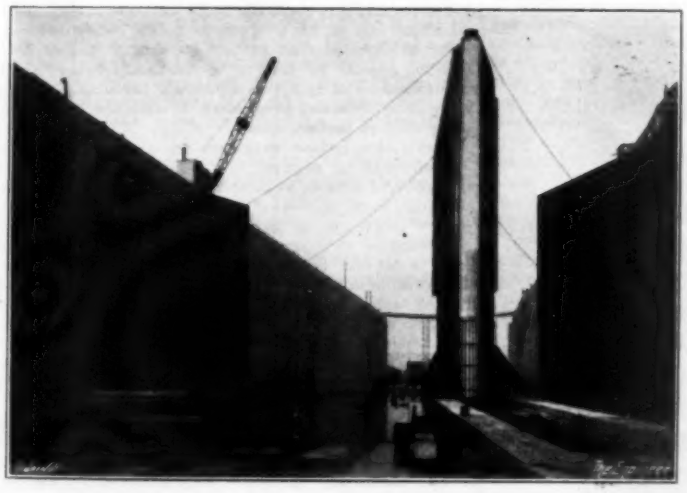
For the reason above stated, the Gladstone graving dock was constructed first, and that necessitated the provision of an entrance channel direct from the river. This channel was always intended to be more or less of a temporary nature, and when the works were finally completed it was done away with and access to the dock is now only obtainable from the vestibule or turning dock.

The length of the graving dock from the head to the inner caisson sill is 1050ft. The width of the entrance is 120ft., and the width of the dock at the bottom 141ft., while the width at the top is 155½ft. At high water of spring tides the depth of water on the sill of the dock is about 43½ft. A single storey shed extends the full length of the north quay. For handling goods between vessels in the graving dock and the single-storey sheds on the north side, there are 30-cwt. electric cranes travelling on one rail at the outer edge of the quay, and on another on the top of the front wall of the shed, as mentioned above.

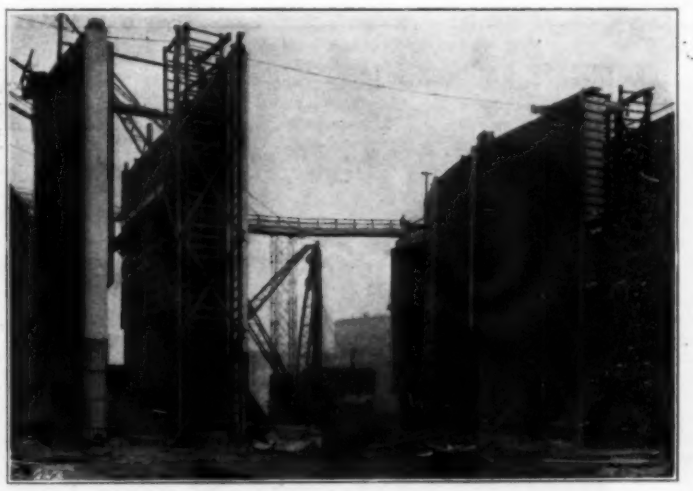
In order that the dock may be rapidly cleared of water when required for use as a graving dock, there has been installed a pumping plant consisting of five sets of centrifugal pumps, with discharge pipes 54in. diameter, and each driven by a vertical four-cylinder two-cycle Diesel engine, running at 180 revolutions per minute, and capable of developing 1000 horse-power. These pumps can empty the dock of its contents, amounting to about 44 million gallons, on a 28ft. tide in 2½ hours. This dock was built by first tipping a dam around the site of the works. This dam was made with a clay core, and was formed with a rubble face on the outward sides. After being completely enclosed, the graving dock walls were built in timbered trenches. The main north-south river wall has been extended to the outer end of the tipped dam to enclose the dock area completely.

The wet dock system comprises the vestibule or turning dock, having a water area of 24¾ acres, entered from the river by a new river lock entrance, and from the existing dock system by means of another and smaller lock. There are two branch docks, one 1420ft. long and 400ft. wide, and the other 1285ft. long and 400ft. wide. These have treble storey ferro-concrete sheds on the north and south sides. The south shed of No. 1 dock measures 1502ft. long by 150ft., and the north shed 1252ft. by 100ft. Altogether they cover an area of about 8 acres, and the total floor area, including the flat roofs, which are designed to take light loads, will amount to nearly 32 acres. The ground floor area and the total floor area of the sheds of No. 2 branch dock are approximately 5¾ and 23 acres respectively.

A 40ft. passageway is provided between the front of the shed and the quay edge on the south side of branch dock No. 1, and two lines of railway track are laid along the quay, one of which runs between the legs of the 30-cwt. travelling electric cranes. These cranes can handle material to a ship from wagons on either of the railway tracks or from the quay to any floor or the roof of the shed, or, of course, *vice versâ*. The south side of the shed is provided with 20-cwt. roof cranes, which have a reach over two railway tracks and can deliver material to a wagon standing in the roadway beyond two lines of trucks. The sheds between the two branch docks are provided with 30-cwt. roof cranes on the water side and 20-cwt. roof cranes on the road sides. The sheds are of reinforced concrete throughout. Some idea of the capacity of the docks can be gathered from the fact that the quays are 63ft. above dock bottom. The work of construction was carried out in timbered trenches. The walls are of mass concrete and there is a tunnel below the quay and above high-water level for carrying water service pipes, electric cables, &c.



ENTRANCE LOCK GATES, HAULING LEAF INTO POSITION

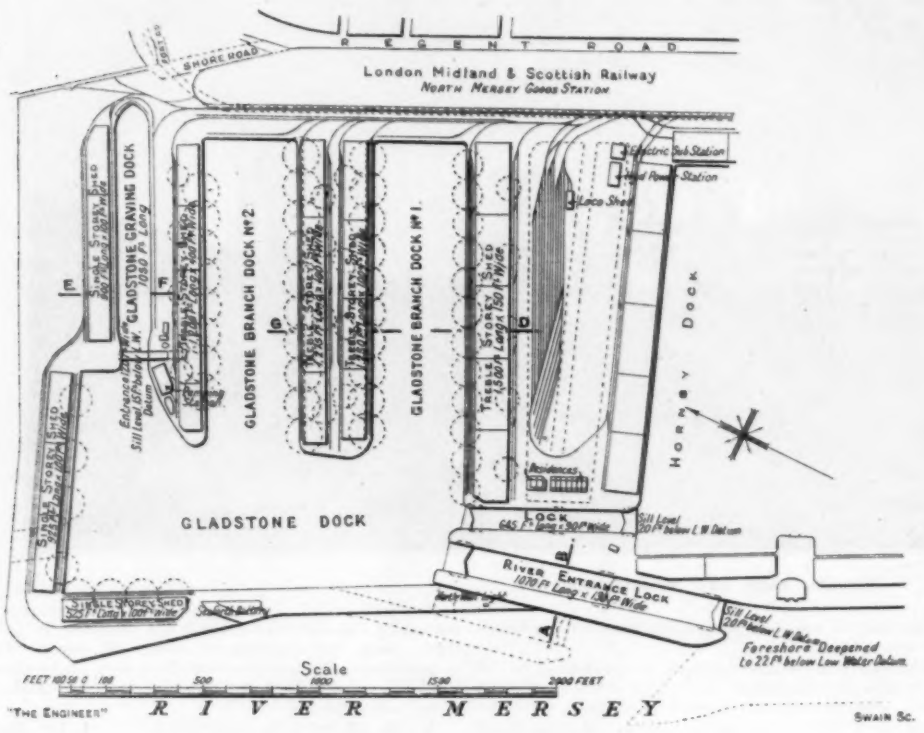


MIDDLE AND OUTER ENTRANCE LOCK GATES UNDER CONSTRUCTION

The new river lock entrance is 1070ft. long and 130ft. wide, divided into two sections, and having sills 30ft. below Old Dock Sill, or 20ft. below Bay Datum. This will give the following depths of water on the sills:—At low water ordinary spring tides, 22ft.; at low water ordinary neap tides, 27ft. 6in.; at half-tide level, 35ft.; at high water ordinary neap tides, 42ft. 9in.; and at high water ordinary spring tides, 48ft. 4in.; thus enabling the largest ships afloat to go in and out on every tide of the year, while ordinary sized ships, having a draught of, say, 28ft., will be able to pass in and out of the dock at any time of any day, except for a very small number of hours each side of low water on spring tides.

The new river lock entrance cuts across the line

of the old river wall and part of the outer wall is outside this line. This outer wall was constructed inside sheet steel piling reinforced by timber work and pile structure connecting it to the old sea wall. The Wind screens 20ft. high are to be provided along the river front, and on the north and west quays of the vestibule dock single-storey sheds with cranes and rails are being erected.


REGENT ROAD
SHORE ROAD
London Midland & Scottish Railway
North Mersey Goods Station
Electric Sub Station
Hydraulic Power Station
Loco Shed
GLADSTONE GRAVING DOCK
1050 Ft Long
GLADSTONE BRANCH DOCK No 2
GLADSTONE BRANCH DOCK No 1
Transit Shed
Transit Stores
Hornby Dock
Residences
GLADSTONE DOCK
LOCK
645 Ft Long x 90 Ft Wide
Sill Level 20 Ft below L W Datum
RIVER ENTRANCE LOCK
1070 Ft Long x 100 Ft Wide
Sill Level 20 Ft below L W Datum
Foreshore Deepened to 22 Ft below Low Water Datum
Scale
FEET 100 50 0 100 500 1000 1500 2000 FEET
"THE ENGINEER"
R I V E R M E R S E Y
SWAIN Sc.

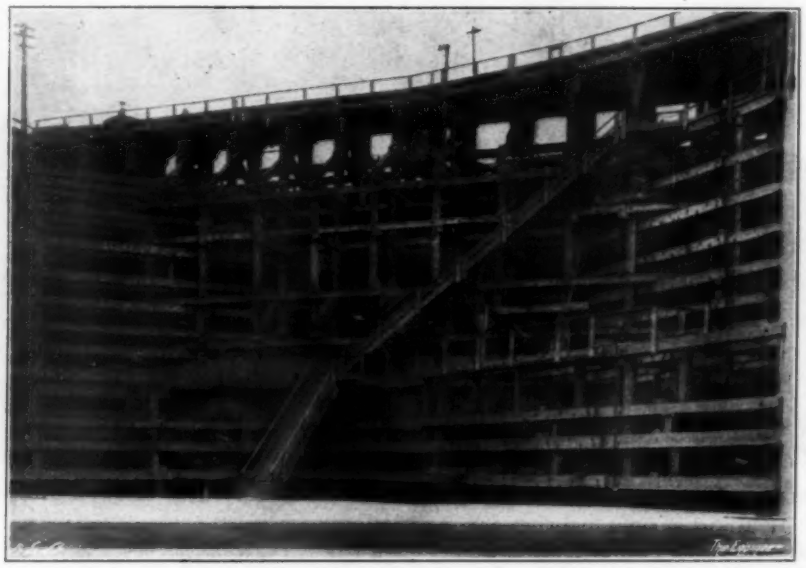
PLAN OF THE GLADSTONE DOCKS

piling was supplied by the British Steel Piling Company, Ltd. The gates for the river entrance lock are shown in one of the engravings. There are three pairs, *i.e.*, six leaves. They are of steel, 56ft. high, and are claimed to be the largest hinged gates in Europe. They were built by Sir W. G. Armstrong-Whitworth and Co., Ltd., to the designs of Mr. Thomas M. Newell, M. Inst. C.E., engineer-in-chief to the Mersey Docks and Harbour Board. A special feature of the method of suspension of the lock gates is its simplicity. At the bottom the gates are mounted on a saddle or bracket, in which fits a plain steel pintle, and at the top the gates are

The complete crane and jigger equipment is as follows :—

	Electric movable cranes. Quayside. 30 cwt.	Electric movable cranes. Roadside. 1 ton.	Hand lowering jiggers, 15 cwt. Inside.	Hand lowering jiggers, 15 cwt. Roadside
Gladstone Dock	4	—	—	—
Branch No. 1 South	12	5	15	15
Branch No. 1 North	10	4	12	12
Branch No. 2 South	10	4	12	12
Branch No. 2 North	9	4	12	10
Total	45	17	51	49

With the exception of a certain amount of dredging and the removal of the entrance dam, the whole of



VIEW OF DAM FROM INVERT OF LOCK

secured by a simple strap in which they can turn. The weight of each leaf of these gates is 500 tons.

The smaller lock which serves to connect the Gladstone docks with the Hornby Dock is 645ft. long by 90ft. wide, and is thus large enough to permit most modern ships to pass through. It will also serve to permit vessels of deep draught to pass from the existing docks into the Gladstone basin at times when there is an insufficient depth of water in the river to allow these ships to pass out by their usual river entrances. The dock sheds are provided with rail facilities both at the dock and roadsides, and these are in communication with adjoining railway companies' goods stations. Provision is made for the efficient handling of railway wagons by a complete system of electric capstans at all the sidings which serve the sheds.

the work is now practically complete, as will be gathered from the photographic illustrations given herewith, which were taken some months ago. The work, reproductions from photographs of which are given herewith and on page 384, has been carried out by direct labour under the supervision of Mr. Thomas M. Newell, M. Inst. C.E., engineer-in-chief to the Mersey Docks and Harbour Board.

Shipbuilding in Russian yards is proceeding very slowly, according to the latest statement of the administration of the Soviet Merchant Fleet. On January 1st there were seventeen ships with a cargo capacity of 48,110 tons on the ways.

The Atmospheric Corrosion of Metals.

Some interesting and important results of further investigation into the corrosion of non-ferrous metals were given at a meeting of the Faraday Society, held in the rooms of the Chemical Society, Burlington House, Piccadilly, W. 1, on Wednesday, March 30th, when Dr. W. H. J. Vernon presented the Second Experimental Report to the Atmospheric Corrosion Research Committee of the British Non-Ferrous Metals Research Association. The first report was presented in 1923.

It is interesting to note that this work had its genesis in a suggestion by the Royal Institute of British Architects that the corrosion of non-ferrous metals, particularly in relation to furniture—ironmongery and so on—was a matter of great importance and one which invited investigation. The Institute of Metals then took up the subject, and eventually the Department of Scientific and Industrial Research was interested, and the British Non-ferrous Metals Research Association appointed the Committee.

The work recorded in the first report was occupied with the systematic examination of the behaviour of the commoner metals on exposure to several types of indoor atmosphere and to the open air, employing both loss of reflectivity and increase in weight to estimate the changes taking place at the metal surface. In the work recorded in the present report the examination of the various metals was carried to a further stage, additional and generally more intensive experiments having been instituted. These were concerned chiefly with the mechanism involved in the formation of various films on exposure to air, with particular reference to the conditions under which protective oxide films might be obtained. To this end attention was directed mainly to copper, partly because of its intrinsic importance, and partly because of its special liability to become tarnished. It was thought that information so gained might be employed usefully in the examination and treatment of the many alloys in which copper was the major constituent. At the same time, zinc and brass received more critical attention than was the case in the earlier report.

This second report was a lengthy document running into some seventy pages, including many digrams and tables, and it was divided into two parts, dealing respectively with indoor and open-air exposure tests, the former including associated laboratory experiments. One generalisation to which Dr. Vernon drew attention was that conclusions which held good for a given set of conditions did not necessarily apply when those conditions were changed. This was exemplified by the influence of impurities in copper. Indoors, under conditions such that only tarnishing had to be considered, a given element exercised an effect which was either negligible or in simple proportion to the amount of element present. Exposed to the open air, however, the same element might exert an effect out of all proportion to its concentration. It would appear that protection against indoor tarnishing should be sought by methods other than modifications of composition alone; promising results have been obtained in connection with the formation of protective surface films.

From the indoor exposure tests and laboratory experiments on copper, it was concluded that the intensity of attack, as measured by weight-increment per unit area, increased with the coarseness of the emery employed in abrasion As to the influence of chemical cleaning, it was found that treatment with solutions containing nitric acid was without appreciable influence upon the behaviour of the metal during subsequent exposure. Solutions containing chromic acid, on the other hand, produced a considerable degree of immunity from tarnishing, which immunity might be destroyed by treatment with ammonium chloride. The influence of purity of metal upon rate of tarnishing appeared to be negligible—although modifications of composition might have pronounced effects upon the corrosion of copper under conditions of complete exposure to the open air.

The tarnishing of copper was initiated by atmospheric sulphur in such form as to respond to the alkaline lead acetate test. The minimum concentration necessary for tarnishing, however, was extremely small, equivalent approximately to 1 volume of H_2S in 600 million volumes of air. Above this value tarnishing started, and proceeded at a rate proportional to the "reactive" sulphur content of the atmosphere. When once a tarnish film was formed, increase of thickness followed accurately a parabolic relationship with time, though the atmospheric sulphur content might fluctuate within extremely wide limits—*i.e.*, the rate of tarnishing was determined by the conditions prevailing at the time of the first exposure.

It was concluded, from investigations into the composition of tarnish films and the mechanism of their formation, that tarnish films consisted essentially of isomorphous mixtures of oxide and sulphide, and that, in the case of an initially clean surface under ordinary conditions of exposure, the surface was activated by the impingement of sulphur atoms, which entered into the formation of the first—mainly oxide—lattice; their relative distribution in this primary lattice then determined the rate of diffusion and the whole subsequent course of tarnishing. There

was reason to believe that if the first oxide lattice were completed before sulphur atoms could impinge—in the form and in the concentration in which they commonly occurred in the atmosphere—their subsequent entry in any appreciable amount was prevented, and hence tarnishing was inhibited.

When, at ordinary temperatures, the content of atmospheric sulphur fell below the limit necessary for tarnishing, the formation of a thin film of oxide took place. This film was unaffected by subsequent increase in the atmospheric sulphur content, within the usual limits—*i.e.*, it was resistant to tarnishing.

At the ordinary temperatures there were two alternative types of film possible, *i.e.*, the tarnish film and the protective oxide film, according to the relative purity of the atmosphere, but at higher temperatures the latter type was developed to the exclusion of the former. There appeared to be a critical thickness of film necessary for protection to be afforded against subsequent tarnishing. For one hour's heating this film was produced between 55 and 75 deg. Cent. The evidence led to the suggestion that the minimum thickness of film necessary for protection was such that the unit lattice of the oxide was completed for the whole of the surface.

With regard to the protective effects of smoke films, it was found that close contact with smoke from cellulose produced a considerable degree of immunity from tarnishing on subsequent exposure.

In the case of zinc, a linear relationship between the weight increment of the film and the period of exposure was found in the earlier experiments, and in this later work it was confirmed for relatively long periods of exposure. It was concluded that the oxide films developed upon zinc at the ordinary temperature must have a granular structure, through the interstices of which gaseous diffusion of the atmosphere took place. Direct evidence of that had been obtained by examination under the microscope. Moreover, any colour effects should be due to diffraction and not to interference of light. That was confirmed by the regular appearance of a blue tint, without passage through the sequence of colours which was characteristic of interference.

With regard to the relation between weight increment and time in the case of brass, it was stated that in an atmosphere of varying but mainly low relative humidity, both 70/30 and 60/40 brass for a considerable time simulated the behaviour of copper and yielded curves which approximated very closely to the parabola. After more extended exposure, however, they reverted to the straight line which was characteristic of zinc. In a more humid atmosphere the resemblance to the behaviour of copper seemed to disappear altogether. Tests on the effect of atmospheric exposure of the microstructure of 60/40 brass showed that in an atmosphere of low relative humidity, containing traces of sulphur compounds characteristic of winter-time town air, the attack was chiefly directed upon the alpha constituent, which tarnished in a manner similar to copper. Subsequently, and more rapidly the greater the humidity, the beta constituent was attacked, but the film was no longer continuous, taking the form of isolated pits, giving rise to an apparently duplex structure. It was suggested that that phenomenon was connected with the departure from the parabola to the straight line.

The film of oxide produced at the ordinary temperature by exposure to a relatively pure atmosphere, while affording considerable protection to copper, had relatively little effect upon the tarnishing of either 70/30 or 60/40 brass. Films produced at higher temperatures, however, exerted a greater protective influence. When brass was exposed to a relatively humid atmosphere, a considerable degree of protection might be obtained by treatment with lanoline, combined with heat treatment at 100 deg.

The following summary was given of the results of tests extending over approximately 3½ years on the behaviour of brass as compared with that of copper and zinc, the materials in each case being arranged in ascending order of the total corrosion they had undergone :—

(A) Atmosphere of varying, but mainly low, relative humidity : (1) Copper, (2) 70/30 brass, (3) 60/40 brass, (4) zinc.

The brasses tended to approach nearer to zinc with increasing time :—

(B) Atmosphere of varying, but mainly high, relative humidity :—(1) Copper, (2) zinc, (3) 60/40 brass, (4) 70/30 brass.

(C) Domestic kitchen : (1) Copper, (2) zinc, (3) 60/40 brass, (4) 70/30 brass. The order was nominally the same as in B, but the attack on 70/30 brass in (C) was very much greater than on 60/40 brass.

Analysis of corrosion products from specimens exposed in the domestic kitchen showed that a certain amount of the attack was due to organic fatty acids, which appeared to act preferentially upon zinc, and gave rise to their zinc salts in the corrosion products.

The measurement of the formation of the primary film of oxide on aluminium in the very early stages of exposure produced a curve which represented a parabola at the outset, but which quickly flattened towards the time axis, indicating an extremely rapid retardation in the rate of attack. The type of curve suggested that adsorption might play an essential part in the mechanism of oxidation in that instance. In from ten to fourteen days, the primary film practically ceased to thicken. Assuming the film to consist of alumina, either anhydrous or hydrated, the weight increment corresponded to a thickness of the order of 100 A.U. Subsequent increases in weight were probably due to the formation of cracks or fissures in the primary film.

In the case of lead a weight-increment curve of the same type was obtained, but the nearly flat portion of the curve was reached in about seven days, and the weight increment was then only a little more than half that which obtained for aluminium. As in the case of aluminium, the film was completely invisible. In the presence of traces of vapours from drying paint, freshly cleaned lead underwent rapid oxidation, and, in a week or so, became deep blue in colour. Of all the materials examined, that effect was peculiar to lead. If, however, the metal had been exposed for a sufficient length of time to uncontaminated atmosphere, it was immune from such attack, owing, no doubt, to the formation of a protective film of oxide.

Iron was another metal tested. In an ordinary room atmosphere of low relative humidity, such as obtained under conditions of artificial heating, the process of rusting was controlled entirely by suspended solid impurities in the atmosphere. The rate of attack fell off with increasing time, and rusting might be stopped entirely either by filtering the air or by screening the specimen behind a single thickness of muslin. During such time as the iron was exposed to an atmosphere screened from solid particles, it developed a protective film. On subsequent (normal) exposure this film resisted attack for a time, but then broke down at certain points, following which the localised attack proceeded at an accelerating rate. In an atmosphere of relatively high humidity, such as might obtain in an ordinary room not artificially heated, and in the presence of suspended solid particles, the rate of attack accelerated from the start, owing to the deposition of particles and concomitant precipitation of moixture. Rusting could still be prevented by screening behind muslin. If iron already covered with dry rust were exposed to an atmosphere of the necessary relative humidity—actually not more than 70 per cent.—an extraordinary acceleration of the rate of attack occurred. These phenomena were observed equally upon ingot iron of commercial quality, highly purified iron, and upon steel containing 0·5 per cent. carbon. In an atmosphere saturated with water vapour, rusting of the iron took place in the absence of suspended solid particles. The rate of attack accelerated from the start, yielding a curve which was concave about the weight axis.

The open-air exposure tests were carried out on specimens of copper, 70/30 brass, 60/40 brass, and zinc in various physical conditions. Rain water was collected from beneath these specimens and subjected to analysis at intervals, and information thus obtained concerning the weight of metal removed in relation to the period of exposure. For the whole of the time in the case of copper, and for the major part of the time in the case of other materials, a linear relationship was found. The order in which the materials were affected by "erosion"—which was defined as that type of corrosion which resulted in the removal of material from the metal surface—was as follows :—Zinc, 70/30 brass, 60/40 brass, copper. In the case of the brasses there was excessive preponderance of zinc over copper in the soluble products.

From the weight of metal removed, and the initial and final weights of the specimen, a value was obtained for the "surrosion," represented by the residual products adhering to the specimens. Analyses of these products were carried out in all cases, and the order of "surrosion" was as follows :—60/40 brass, 70/30 brass, copper, zinc. Finally, by the summing of erosion and surrosion respectively, values were obtained representing the total corrosion of the specimens, in which respect the materials came out in the following order of corrodibility :—60/40 brass, 70/30 brass, zinc, copper. Further test, representing over four years' exposure, had been conducted upon various grades of copper, together with 70/30 brass, 60/40 brass and zinc. The order of resistance to corrosion was as follows, the figures indicating the approximate total corrosion, that of H.C. copper being taken as 100 :—

Copper with 0·45 per cent. arsenic	43
Copper with 2·5 per cent. nickel	61
Copper with 0·8 per cent. tin	76
Ordinary copper	81
H.C. copper	100
70/30 brass	140
Zinc	155
60/40 brass	227

In connection with the high resistance displayed by arsenical and nickel copper respectively, it was noted that within the first few days of exposure these materials, among the copper specimens, showed the most rapid loss of reflectivity.

Mr. J. C. Hudson, who was appointed about two years ago to arrange for the outdoor tests, said that the greatest difficulty had been to devise quantitative methods of measurement sufficiently sensitive to detect the changes produced in a reasonably short period. That difficulty, however, seemed now to have been satisfactorily solved in two distinct ways, first by the introduction of a method in which the electrical resistance of a wire was measured accurately before and after corrosion, and secondly by the application of Dr. Vernon's weight-increment method outdoors to specimens sheltered from the rain by enclosure in a Stevenson screen. A third test was, possibly, the loss in weight test. Preliminary investigations on the application of those methods had been completed, and in the course of a month or so it was hoped to begin a series of tests on fifteen typical nonferrous metals by the three methods indicated. Provision had been made for exposure at five different stations, typical or rural, urban and industrial atmospheres.

Discussion.

In the course of the discussion upon the report a good deal of emphasis was laid by a number of speakers upon the practical value of the results obtained. As an example, it was pointed out by Professor H. C. H. Carpenter that it was shown to be possible to form a protective oxide film on copper by heating at a temperature as low as 75 deg. Cent., and so obtain a metal which was apparently unchanged, but which would resist the tarnishing effect. That heating should not add very much to the cost of the process. He pointed out, however, that the film did not always give complete protection, and he suggested further experiments with a view to making the protective effect permanent. The permanency of the protective film on aluminium, for instance, could be increased by depositing the oxide under specified conditions, and that method was used regularly for the protection of duralumin used for aircraft. The practical bearing of Dr. Vernon's work seemed to be that the alloys were less resistant to tarnishing and corrosion than were the pure metals.

This question of the resistance of pure metal to corrosion was also raised by other speakers, including Professor E. Wilson, who asked whether it was a fact that the present-day high-grade quality of aluminium did not corrode. Professor C. H. Desch—who presided—said that the difference in the behaviour of a 99·2 per cent. pure and a 99·6 per cent. pure metal was not very great from the corrosion point of view ; it was only when the impurity was increased considerably that the great difference occurred. Aluminium 99·95 per cent. pure was now on the market, and he believed that its resistance to corrosion was much greater than that of commercial aluminium, which was only a little over 99 per cent. pure. Zinc also was produced which was said to be 99·9999 per cent. pure ; it was not affected by sulphuric acid or hydrochloric acid, and remained bright in air. Commercial metals on the market were far from being pure ; a 99·8 per cent. metal was not a pure metal.

The point made by Dr. Vernon, that the corrosion of iron began by the deposition of solid particles from the air on the iron was one which, naturally, was of great interest to Dr. J. S. Owens, the meteorological expert. Iron, he pointed out, was used by engineers to a greater extent than any other metal, and the fact that the corrosion would not have begun if the particles were not deposited from the air impressed him as being of great importance. The purification of the atmosphere, therefore, would have a profound effect on corrosion, and he pointed out that since 1916 the amount of sulphur deposited from the London air had been halved.

Dr. W. H. Hatfield (of the Brown, Firth Laboratories, Sheffield) also referred to corrosion of iron resulting from the deposition of dust and moisture upon its surface, and said that the problem was solved by the addition of chromium, and particularly chromium and nickel to the iron. If one added from 15 to 20 per cent. of chromium, and from 6 to 10 per cent. of nickel to the iron, a prepared surface could be exposed to the London atmosphere or a marine atmosphere without being attacked. In his opinion that was due to the modified film produced as the result of the addition of chromium to the iron. Dr. Vernon's view, expressed later, was that it was linked up with the question of the formation of oxide films and passivity. Discussing his own work on the resistance to corrosion of metals at high temperatures, Dr. Hatfield said that an interesting fact was that at high temperatures nickel increased the resistance of iron to the attack of SO_2, oxygen and other gases. If nickel alone were exposed to SO_2 at 700 or 800 deg. Cent., it was attacked very rapidly, and there was a progressive thickening of the products of the attack. If the temperature were increased progressively, however, at about 1000 deg. Cent., the attack of the SO_2 produced a very thin and extremely adherent film, which protected the metal from further attack.

A fact which was commented upon by a number of speakers in the discussion was that Dr. Vernon had been able to achieve great consistency in his results, and, in view of the many variables which entered into the corrosion problem, that fact caused no little surprise. Apparently that consistency surprised Dr. Vernon as much as anyone else, but it was pointed to by many as an indication of the care with which the work was carried out, and Dr. Vernon was deservedly congratulated.

The suggestion was also made that information even more valuable than that already obtained might have resulted if the number of metals dealt with had been less. Dr. Hatfield pointed out that Dr. Vernon was attempting to deal in an empirical way with a very big field, and it might have been better if he had

devoted his attention in a more concentrated form to one or two metals. Dr. Vernon's reply was that until a fairly wide field had been covered he could not get the right perspective, but he agreed that the time had now come when the field might be limited.

Institution of Mechanical Engineers.

The second of two joint meetings to discuss modern lubrication problems, arranged by the Institution of Mechanical Engineers and the Chemical Engineering Group of the Society of Chemical Industry, was held in London on Friday evening of last week. The paper presented was entitled "Lubricating Oils—Laboratory in relation to Practical Results," and was the work of Mr. A. G. Marshall and Mr. C. H. Barton. It described tests carried out by the authors in co-operation with Mr. H. R. Ricardo, and formed a supplement to Dr. W. R. Ormandy's paper, entitled "Lubrication," presented at the first joint meeting a fortnight ago. The chair at last Friday's meeting was occupied by Mr. F. H. Rogers, chairman of the Chemical Engineering Group.

The paper was based on the thesis that, in practice, the lubrictaion of machinery is carried on in complete independence of the scientific theories of the subject. Engines, the authors stated, ran quite indifferent to the quality of the lubricating oil as judged by the criteria advanced by the scientific side. For some years the authors have been investigating the laboratory properties of lubricating oils, the results obtained being constantly checked by actual trials under operating conditions. If the engine did not show the results which would have been prophesied from the laboratory test, so much the worse for the laboratory test; its conditions evidently did not correspond with practical requirements.

The first property of a lubricating oil dealt with by the authors was its "oiliness" as judged by the Deeley machine. This machine measures the coefficient of friction between lubricated surfaces and the higher the Deeley figure the lower is the oiliness of the lubricant said to be. Mineral oils are found to have a coefficient of friction of 0·15 to 0·18, and fatty oils, values of the order of 0·10. Mixtures of mineral and fatty oils have intermediate values which rapidly approach that of the straight fatty oil, as comparatively small proportions of fatty oil are added. The effect of oiliness in practice was examined by the authors by means of a special piston testing machine, a single-cylinder engine without valves or sparking plugs, with its crank driven by an external motor. The friction was measured by means of the torque required to drive the engine. The results obtained showed no difference between straight mineral oil and an oil of the same viscosity compounded with 10 per cent. or even 20 per cent. of fatty oil. A similar negative result was obtained by measuring the frictional horse-power of actual engines. It was only when the lubrication was reduced almost to vanishing point that any difference between the straight and the compounded oil could be detected. Oiliness had no effect under conditions of lubrication as economical as most practical engineers would care to use. When special conditions were arranged in order to elevate the cylinder wall temperature to as much as 200 deg. Cent., it was found that straight mineral oils gave the best results. Some lubricants containing fatty oils failed to finish the test, the engine seizing chiefly as a result of the decomposition of the oil.

Consideration was next given to the effect of oiliness on wear. Specially designed bearings were constructed in which the rubbing pieces were portions of metal which were weighed in a chemical balance before the test and after 10,000,000 revolutions. The results showed a decreasing amount of wear with time as the bearings became "run in," but the wear curves were not affected by interchanging mineral oil and compounded oil of the same viscosity. In four cases the journals were of aluminium and the bearings of bronze. In three cases the journals were of bronze and the bearings of white metal. It was concluded from these various experiments that oiliness measurements cannot be relied upon to indicate the general practical value of a lubricating oil.

The second criterion examined was the tendency of an oil to give carbon deposits. The laboratory tests devised to examine this tendency consist of (*a*) determining the coke residue produced on the rapid heating of the oil in the absence of air, and (*b*) oxidation tests followed by visual examination (Hoblyn's test), a determination of the change of viscosity (Air Board test), or precipitation with petroleum ether (Waters' test). None of these tests was found to give any indication of the results to be expected in an engine. Of two mineral oils examined, that which gave definitely inferior results, as judged by the various carbonisation tests, was found in the engine to be superior. The friction, the oil consumption and the carbon deposited on the piston were all less with it than with the other.

In another series of experiments under the same heading, the oil from the crank case was circulated through a small centrifuge to investigate the amount of sludge formed in the oil. Four unmixed oils possessing considerably different laboratory test characteristics gave sludge test results either the reverse of what would be expected from the laboratory tests or exhibiting differences which required careful measurement to detect. The coke values of the same four oils failed completely to agree with the amount of carbon which, during the sludge tests, was deposited on top of the piston. Three mineral aero oils were tested similarly. The oil which was definitely the best as judged by the Air Board test specification gave in the engine the greatest amount of sludge and the greatest deposit of carbon on the piston head.

The concluding portion of the paper was devoted to an examination of the viscosity of oils, the manner in which it changes with temperature, and how such manner of change affects the lubrication of engines. The conclusion reached by the authors is that the commonly accepted rule, "the flatter the viscosity curve the better the oil," is misleading in connection with questions of power and friction, and is incomplete in connection with questions of starting effort. If, they say in effect, two different oils have the same viscosity at some medium temperature, say, 100 deg. to 140 deg. Fah., then the oil with the steeper viscosity curve will have the lesser viscosity at the temperature of the cylinder walls, and consequently will result in a reduction of frictional losses. In an extreme case two oils, matched at 46 deg. Fah., were found to give a practically constant difference in the power output of an engine of 2 per cent. in favour of the oil of the steeper viscosity curve. Below the matching temperature the oil with the steeper curve would be expected to increase the starting effort required. On this point the authors' experiments have not yet reached finality, but the evidence they have so far collected suggests that the opposite is true as a result of the flat curve taking at some fairly low temperature an upward trend and crossing the steeper curve. As a consequence at starting temperatures the flat curve oil may have a viscosity actually greater than that of the steep curve oil.

Dr. W. R. Ormandy, opening the discussion, said that according to the authors there was less relationship between the science and art of lubrication than there might be. In his view the paper was scientific, but the deductions contained in it were "artful." The authors argued that the property known as "oiliness" in an oil was an unknown quantity, which could not be measured and which in any event, from the practical user's point of view did, not matter. He, Dr. Ormandy, on the contrary, believed that hundreds of examples could be given to show that oiliness did exist, and that it was an important property of lubricating oils. The authors' deductions were based on experiments with mineral oil to which additions of rape, coconut, whale and other vegetable and animal oils had been added to improve their oiliness. Why had they selected these oils? Why, he facetiously remarked, had they omitted linseed oil and other oils celebrated for their gumming properties? Southcombe, Hardy and others had definitely shown that it was the fatty acid constituent of the added oil which effected the improvement in the oiliness factor. The authors' results, which were claimed to show that an oil definitely inferior to another when judged in the laboratory with respect to its coke value and its reaction to oxidation might be superior as a lubricant under practical running conditions, could not be allowed to pass unchallenged. He emphatically believed that an oil which gave a bad asphalt percentage after oxidation would behave badly in the crank case of an engine, and that the oil which oxidised least would give the best results in the cylinder. He also disputed hotly the authors' conclusion that no justification existed for judging oil by the changes which occurred in its viscosity above 70 deg. Fah. Contrary to the authors, he maintained that the flatter the temperature-viscosity curve of an oil was the better would the oil be as a lubricant. The authors' argument against the flat curve seemed to be that at very low temperatures it took an upward turn. But what happened to the oil at temperatures which did not occur in practical use did not seem to him to have any bearing on the question. The chief wear in the cylinder of an engine occurred at the ends of the piston stroke, that was to say, at the points at which the piston stopped and reversed its motion. He believed that at those points film lubrication was obtained, and that practical conditions were therefore realised better by static tests than by running tests.

Mr. H. M. Martin thought the paper was a model of what an industrial research paper should be, although there were one or two points on which the conclusions arrived at seemed to be a little more definite and decided than the facts warranted. Mr. Martin then proceeded to refer to certain experiments described by Sir William Hardy in 1923, and gave his own views on the phenomena observed.

Mr. J. H. Hyde, of the National Physical Laboratory, said that if the authors' contention were true, that the usual laboratory tests could give no indication of the tendency of an oil to form a deposit in use, it would be necessary to modify the laboratory tests. The value of the paper would have been greatly increased if an alternative test had been suggested. The tests described by the authors were really laboratory tests, although they were intended to be practical tests. They were not practical to anything like the degree of the extensive series of lubrication tests that had been carried out by Messrs. Tilling on the engines of their motor omnibuses. After many months of careful investigation, Messrs Tilling concluded that an "oily" oil was most decidedly the one to use. Whatever oil was employed produced little difference in the wear on the crank shaft or at the big ends of the connecting-rods, but there was a decided difference in the effect on the diameters of the cylinders. He would not expect the value of oiliness to be made apparent in the authors' experiments, for the lubricant was used in profusion and not under the conditions necessary for the establishment of film lubrication.

Mr. Harold Moore said that the authors, comparing four oils, had found that the laboratory tests conducted on unoxidised and oxidised samples failed to agree with or greatly exaggerated the difference between the behaviour of the oils as judged in the sludge testing engine. He would agree with that deduction only if the possibilities for oxidation present in the conditions under which the oils were used in the engine were not marked. Had the trials more nearly reproduced the conditions existing in a petrol engine—conditions involving the retention of the oil in the crank case for anything from six to twelve months—then in his opinion the asphalt figures given by the laboratory tests would have a definite practical significance.

Mr. C. H. Barton, joint author of the paper, at this point gave the meeting particulars of tests conducted on two oils subsequently to the writing of the paper. The results, he said, seemed to epitomise the remarks made in the paper regarding oxidation and carbonisation tests. Both the oils were mineral oils and the tests had been carried out in the single-cylinder sludge testing engine. The figures given by Mr. Barton were as follows:—

Oil.	S.	T.
Specific gravity at 15 deg. C.	0·896	0·937
Viscosity (Redwood) at 70 deg. F.	3340 secs.	6960 secs.
At 140 deg. F.	303 secs.	330 secs.
At 200 deg. F.	89 secs.	83 secs.
Coke test (Ramsbottom)	0·44 p.c.	0·21 p.c.
Air Board test:		
Ratio viscosity after oxidation to viscosity before oxidation	1·52	2·9
Asphalt	Nil	5·0
Increase in coke value after oxidation	0·81	2·37
Engine Tests.		
Carbon on piston head	1·0 gramme	0·51 gramme
Sludge in centrifuge	0·56 gramme	0·23 gramme
Piston ring wear, top	0·024 gramme	0·019 gr.
" " " bottom	0·031 gramme	0·033 gr.

Mr. E. R. Redgrove said that he had no doubt as to the correctness of Langmuir's views regarding oiliness in oils. Oiliness certainly did exist, but he was uncertain as to whether it was a desirable feature in the case of an engine in which the lubricating oil was kept in circulation for a lengthy period. A mineral oil which he had examined gave after oxidation an increase in the viscosity of 3·6 per cent., an asphalt figure of 2·8 per cent., and an increase in the coke value of 2·0. If the oxidation were carried out in the presence of copper the figures became 11·9, 5·0, and 3·6 respectively. Aluminium was found to have very little effect. With the addition of 1 per cent. of oleic acid the figures given were 13·2, 8·1, and 4·1. An addition of 5 per cent. of lard oil caused the figures to become 12·4, 7·6, and 3·6. It was obvious, he said, from these results that the fatty acid was the real culprit in causing the increases. He argued that carbon deposited on the piston head was not likely to cause an engine to break down. It was necessary, however, to guard against a failure of lubrication at the crank shaft and big end bearings as a result of the thickening of the oil in the crank case and the choking of the oil passages. He thought it wise to select an oil with a low asphalt value, even although it had a high coke figure.

Mr. T. H. Adams, chemist to the Midland Division of the London, Midland and Scottish Railway, agreed with the authors regarding the divergence which existed at present between the theory and practice of lubrication in machinery. Lubrication practice was based mainly upon experience, the specifications being drawn up in the light of the physical and chemical examination of oils which had proved satisfactory in use. The authors' researches had, however, been carried out almost entirely on the lubrication of internal combustion engines, and therefore he held that they were not justified in certain of their conclusions as applied to oils used at temperatures which did not materially exceed 120 deg. Fah. In the course of his remarks, Mr. Adams subjected some of the authors' results to a detailed examination, and described his company's experience with compounded lubricating oils. Compounding, he said, had been found to have very beneficial results. In one group of engines the unpleasantly frequent occurrence of hot axle-boxes was overcome by the substitution for the standard compound oil of a more heavily compounded oil, namely, one to which about 25 per cent. of blown oil had been added. Dealing with the oxidation of lubricating oils, he asked the authors whether they were satisfied that their procedure of blowing air through mineral oils for six hours at a temperature of 200 deg. Cent. really did produce oxidation to the extent stated in the paper. He suggested, as being much more likely, that it would cause volatilisation of some fraction of the oil with a consequent loss of weight.

Mr. F. W. Thorne questioned whether with ordinary engineering surfaces the pools of lubricant formed between the asperities would not affect the mechan-

ism of the lubricating process. Illustrating another remark, he made the interesting statement that if a faced block, 2in. in diameter, were placed on a faced surface with, between the faces, a lubricant having a coefficient of viscosity of 10 dynes per square centimetre per second and if the block were loaded with a weight of 700 lb., it would take thirty-four hours for the two surfaces to come within a wave length of light from each other.

Mr. H. D. Nickinson said that three years ago he had been widely criticised when giving the results of experiments on the lubrication of motor omnibus engines for suggesting that the best method of finding a satisfactory lubricant for omnibus work was to test the oils in actual service. The authors agreed with that view. He, however, thought that the conditions under which they had conducted their experiments did not sufficiently fully reproduce service conditions. The test bench runs were too controlled. All the variables had been eliminated. In practice the temperature and speed constantly fluctuated. Some engines had pistons of cast iron and some pistons of aluminium. Some were fitted with pressure oil feed and some with splash lubrication. In the engines of a portion of the fleet of omnibuses under his charge, he continued, oils with free fatty acid were found to give no beneficial results. Tested at the National Physical Laboratory, the addition of free fatty acid was found to have reduced the coefficient of friction, as determined with the Deeley apparatus, from 0·102 down to 0·090 on the average. When, however, the oil was tested in the Lanchester worm gear apparatus the presence of the fatty acid was found to have raised the efficiency from 93·8 per cent. to 93·97 per cent., a difference within the limits of experimental error. He was led to the conclusion that the Deeley apparatus did not reproduce practical conditions. In a similar way, his experience was that the results of laboratory tests on carbonisation were not borne out in the majority of practical cases. Cast iron pistons collected more carbon than did aluminium pistons. Oxidation tests failed, in his view, on the ground that they made no allowance for the reduction of viscosity caused by the dilution of the crank case oil with unburnt fuel. Such dilution usually resulted in the viscosity of a used oil being lower than that of the original oil. The question of the increase of viscosity as a result of oxidation did not therefore appear to arise. He had, however, a good word to say for the oxidation test as a means of indicating the amount of sludge that was likely to be formed in an engine.

Mr. W. Lee remarked that the Air Board test was especially designed for aeroplane oils, and was therefore rather severe on oils with low boiling-points. In his experience there was a very close relationship between the oxidation and coking tests and practical results.

Professor B. P. Haigh exhibited and described a model of a lubricated journal and bearing designed to illustrate the mathematical theory of lubrication. The circulation of the oil continuously in one direction in the layers next the journal was clearly made visible, as was the secondary circulation in a closed path between the journal and the bearing on the side of the journal remote from the point of nearest approach.

Mr. Marshall, replying to Dr. Ormandy, said that fatty oils had been added to the oils tested instead of oleic acid because such oils were the most common additions used in practice. In one case, the addition of oleic acid was found to have increased the coefficient of friction. All the experiments described in the paper had, so far as was possible, been confirmed on a large scale in a fleet of omnibuses. Mr. Nickinson was very favourably situated to obtain satisfactory results, in view of the large number of vehicles at his command. By averaging his figures, he had been able to eliminate the effect of the variable factors.

A joint meeting of the North-Western Branch of the Institution of Mechanical Engineers with the Society of Chemical Industry (Manchester Branch) was held at the Engineers' Club, Albert-square, Manchester, on Thursday, March 31st, when Dr. W. R. Ormandy presented his paper on "Lubrication."

Mr. J. E. Southcombe, dealing with the mechanism of the formation of the limiting film, said that their views were at least very clear as to how the first layer formed. It was unquestionably the absorption film of orientated molecules. But on films of water all the work that had been done had failed to find any indication of the second layer. Oil films on water were non-molecular, but on solids that did not seem to be true. There was definite evidence that there were many layers above the mono-molecular layer on solids. From work that had been done they knew that at about 10^{-6} cm. of thickness they were in a range of pure fluid conditions. That gave them some idea of the limiting thickness of the film, which was anything from one thousand to nine thousand molecular diameters. Perhaps the most important thing from a practical standpoint was how far the theories of the mono-molecular and super-latent layers influenced, if at all, the running of machinery in conditions of true fluid or Reynolds' type lubrication. At first sight it would appear that once the bearing was running in the condition of Reynolds' lubrication, it was dependent entirely upon the laws of viscosity and was not concerned with the nature of the super-latent films. But, as Reynolds himself had pointed out, that theory presupposed definitely that the surface layer was anchored on to the metallic face, and that the viscous flow at that point was zero. How far the varying form of anchoring on the surface would affect true fluid lubrication was the point that interested him most. There were many indications that molecular orientation in the surface films influenced true fluid lubrication.

Mr. L. G. Radcliffe, dealing with the oxidation of oils, said that he had been studying that question for about fourteen years, and had made a number of experiments on the influence of finely divided metal of all descriptions on the acceleration of oxidation. He did not know whether Dr. Ormandy knew that under certain conditions water accelerated the oxidation of mineral oil, especially sea water. In the lubrication of marine engines and mechanical devices on steamers considerable care had to be taken in the provision of mechanical appliances, to prevent the oil from becoming contaminated with sea water, otherwise oxidation took place.

Mr. A. G. Hopking, referring to the electrical resistance of thin films of oil, remarked that in direct-current locomotives there were at least 1200 to 1500 ampères flowing from the metal structure of the locomotive to the track on its return to the sub-station through oil films in the bearings. He had never heard of any trouble being caused by the return of the current in that way. It occurred to him that the polar type of structure, with its tendency to align itself in straight parallel lines, might provide a path for the current that would not be found in the non-polar type of fluid that did not tend so to align itself.

Mr. R. O. Boswall agreed with the author that lubricating oil certainly did contain a large amount of metallic particles, but he thought that with a bearing working under proper conditions those particles were taken round with the oil. Wear occurred when the bearing was just being started up and the surfaces were more or less in contact. They had definitely proved that bearings with an arc of contact of anything greater than 90 deg. could not work efficiently with film lubrication. With a bearing of about 180 deg. it was not possible to get film lubrication. In such a bearing the oil was bound to leak away at the sides, and, in addition, the heat generated by the friction warmed the oil and the viscosity was considerably reduced.

Mr. R. L. Gregson asked whether aluminium was a favourable metal to use for the manufacture of crank cases from the point of view of its catalytic action in the oxidation of oils.

Mr. Dearnaley said that he had seen a method of treating drops of oil under the microscope with nitric acid of various concentrations. It was claimed that oils could be graded according to their resistance to oxidation by placing them in the order of the strength of nitric acid which caused a sudden deposition of asphaltic compound as viewed under the microscope. The method struck him as a very useful test of the quick examination of oils in the laboratory.

Mr. A. Kersey asked what effect water would have on the lubricating properties of oil.

Dr. Ormandy, in reply, said that a report had been published in Germany a few weeks ago on the investigation of transformer oils as carried out according to the methods in vogue in different countries. An oil which was satisfactory in England was absolutely ruled out in Germany, and one which passed in England and Germany was utterly hopeless in Switzerland. But they all worked. The oxidation of an oil was something about which they were only just beginning to learn. In his own experiments on the question of electrical conductivity he had found no appreciable difference between polar and non-polar oils. A certain amount of work on catalysts had been done, but a lot more remained to be done. That work had to be carried out in the presence and absence of water, and it was highly probable that the presence or absence of inorganic solids would have to be taken into account. They could not say at the moment which metals were most active in bringing about oxidation. He believed that zinc was one of the most active. The possibility of inducing oxidation by means of nitric acid under the microscope was very interesting, but he had no personal experience of the test. The last speaker had referred to the question of water in oil. The tendency to emulsify which an oil exhibited was important in the case of high-speed engines with crank case lubrication. In turbines very great care was always taken to get an oil which did not decompose into acid bodies. If acid were present then the oil would emulsify with the water. The tendency of an oil to emulsify was very largely a function of its tendency to form an acid when it oxidised. That really brought up another point. Certain things would be wetted by an oil and the oil film would stick, and the water would not push it off. Other things were wetted with water and the water would push the oil off. That was the basis of the oil flotation process, which had rendered valuable millions of tons of low-grade zinc ore which otherwise would have been quite useless. The same method was now being used for the separation of dirt from coal.

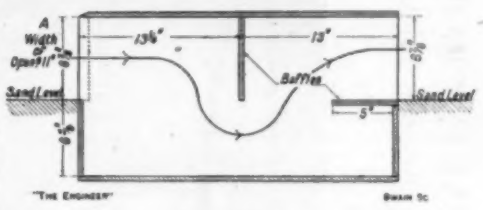
The Movement of Sand by Wind.

By Dr. J. S. OWENS.

It is well known that a strong wind is capable of picking up sand from a damp foreshore and carrying it along in considerable quantities. The following experiments were made to find the velocity of wind required to bring about such sand drift, and the quantity of sand moved under such circumstances. They were made at Holme on the Norfolk coast at the entrance to the Wash, where there is a wide sandy foreshore.

To measure wind velocity, in the absence of a suitable anemometer, the following method was used, and may be worth recording for use under similar circumstances:—

A distance of 44 yards was measured off in the direction of the wind and a mark made at right angles to it at each end; at the up-wind end an assistant was stationed with a supply of thistledowns, which were very plentiful in the neighbourhood. One of these when released could be watched as it was carried down wind. At the down-wind end, in line with the mark made there, the time required for a thistledown to travel over the 44 yards was measured, the moment of starting being indicated by the throwing movement of the assistant's arm. The timing was easily done with a stop watch, and checked by a few consecutive observations. By selecting a distance of 44 yards the velocity of the wind in miles per hour was then equal to 90 divided by the time in seconds required to traverse the 44 yards. The commencement of sand drift was easily observable by eye, but a sensitive check or it was obtained by holding a wetted finger near the surface of the foreshore. If any sand particles were travelling they were easily detected by rubbing between finger and thumb. To measure the quantity of sand moved over a given width a special trap was made, as shown in the accompanying sketch, which is a sectional elevation. It was partly buried in the sand so that the entrance A was flush with the foreshore and facing the wind; there was thus no restriction of area for the passage of wind through the box, the only



SAND TRAP

obstruction being due to the baffles provided to deposit the sand. It was found that this box completely trapped the sand, but there was a slight loss due to the checking of the wind current at the entrance, where some sand banked up; this was taken into account in making the measurement. The result would in any case be to make the measurement on the low side. This sand trap was exposed for definite periods to the drift, and the sand caught measured in a small tin vessel.

Observations were made on August 28th and 31st, and September 1st, 1926, with winds of 6, 9, 13·2 and 15·34 miles per hour, and it was found that no movement of the sand occurred until the wind had exceeded 13·2 miles per hour. The best measurement was obtained at 15·34 miles per hour, the box being exposed for a period of two hours, and during this time the sand was moving over the surface at the rate of 95 cubic feet per hour, calculated over a width of 100 yards, that is, 95 cubic feet of sand passed across a line 100 yards long each hour.

The sand on the foreshore averaged about 0·5 mm. diameter, while the sand trapped ranged from 0·2 mm. to 0·5 mm. It was found that there was a very definite limit to the depth of the sheet of sand moving which, with a wind of 15 miles per hour, was approximately 4in. above the surface. Other observations were made, but owing to gusty and variable wind, the one given was the most satisfactory, as the wind was practically uniform throughout the whole period. As to the mechanism by which this sand is carried in the wind, it would appear that each grain is lifted off the surface, carried a short distance, and then deposited; its place being taken by another grain, the ultimate effect giving the appearance of a continuous stream of sand grains with a depth, in the above case, of about 4in. That the suspension must be intermittent is shown by the fact that where the drift encountered a very wet patch of sand or a pool of water it was stopped within a few feet. Had the drift been due to a continuous suspension of the grains, there appears to be no reason why they should not pass over such wet patches, unless too wide, instead of being trapped. It would seem probable that the grains are lifted in the first instance by impact with others, and that each grain describes a more or less parabolic trajectory. Thus the depth of the drifting layer would increase with the wind velocity, as would also the quantity moved, but the relation of depth and quantity to velocity calls for further experiments to elucidate.

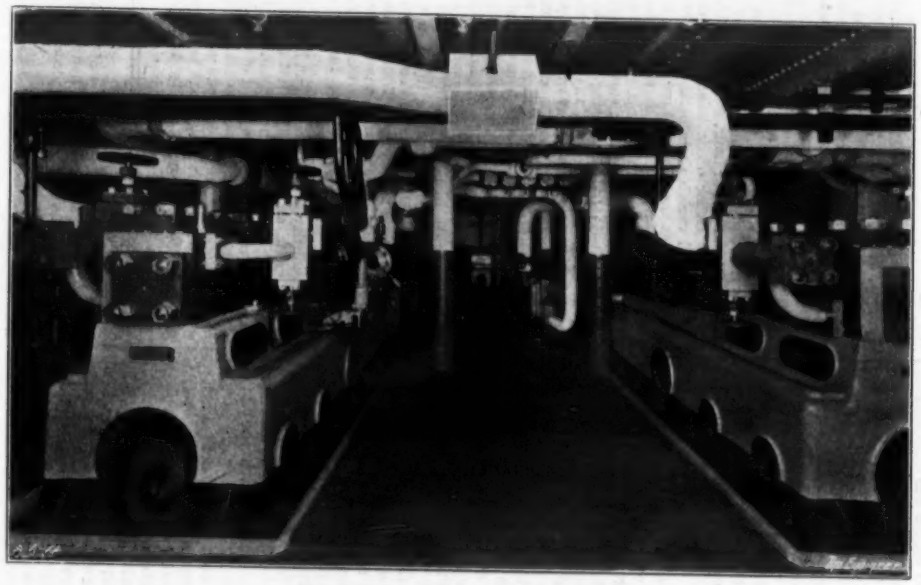
The quantity of sand which can be thus drifted by wind is very great, and its effect is not always fully realised in considering the movements of sand on the foreshore. I have seen in the neighbourhood of the above experiments a new embankment, put in to close a breach in the sea bank, practically buried in sand after a few days strong wind from the sea; it is now, and has been for many years, completely buried, owing chiefly to wind-blown sand.

At the Jolimount workshops of the Victorian Government Railways a clock face has had thirty-one days marked on its dial. There is thereby recorded for each day whether or not there has been an accident in the shops sufficiently serious for the injured man to lose time. It is part of a "No Accidents" campaign, and in a photograph we have seen all the thirty days of November, except two, were free. Seven hundred men are employed there.

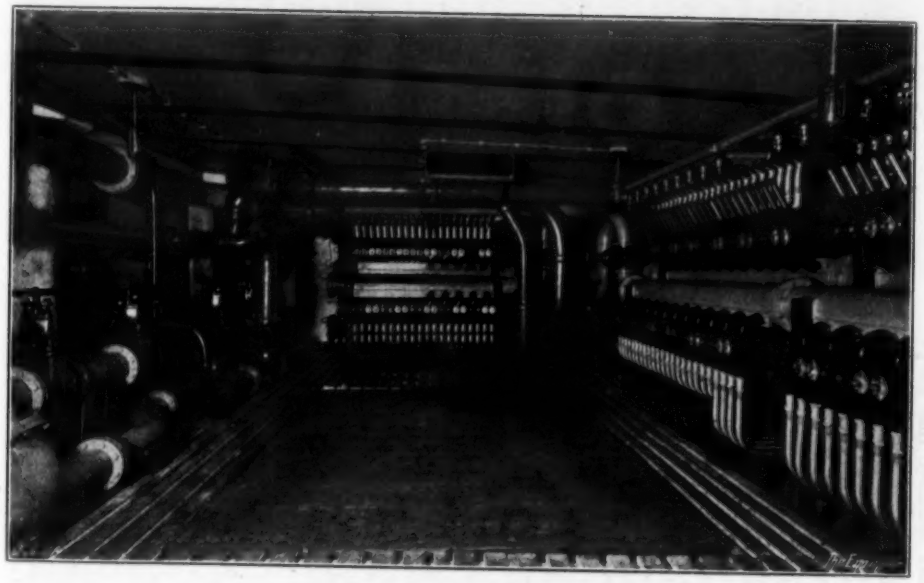
REFRIGERATING EQUIPMENT ON THE BLUE STAR LINER ALMEDA

THE LIVERPOOL REFRIGERATION COMPANY, LTD., LIVERPOOL, ENGINEERS

(For description see opposite page)



REAR VIEW OF THE CO_2 COMPRESSORS



VIEW IN THE AFTER BRINE ROOM

'TWEEN DECK CHAMBER SHOWING BRINE PIPES AND MEAT RAILS

INTERIOR OF NO. 4 FROZEN MEAT HOLD

Refrigerating Machinery on the Blue Star Liner Almeda.

In our issue of December 31st, 1926, we described and illustrated the Blue Star Liner Almeda, which on Wednesday, February 16th, opened a new passenger service between London and South America. The vessel is of interest not alone on account of her geared turbine propelling machinery and her exceptionally commodious and artistically arranged passenger accommodation, but also because she carries a very complete refrigerating machinery equipment, which includes two of the largest CO_2 refrigerating machines yet constructed for any marine installation. As will be seen from Fig. 1, the whole of the vessel's holds and her 'tween deck spaces are insulated for the carrying of chilled or frozen meat. The special type of insulation adopted is that known as the "panel system," which was introduced by Mr. E. A. Thomson, the senior superintendent of the Blue Star Line (1920), Ltd., who designed and laid out the installation we are about to describe, and himself supervised its construction and testing. In all, forty-nine separate insulated chambers are arranged in the upper, lower and orlop 'tween decks, and holds of the vessel, as well as the hold spaces, both fore and aft. As will be noted from the drawing already referred to all spaces with the exception of No. 4 hold—which is fitted for carrying frozen meat—are equipped for the transport of chilled meat. If desired, however, frozen meat can be carried in any or all of the chambers. The cooling evaporators at the company's tank, tube and galvanising works at Warrington.

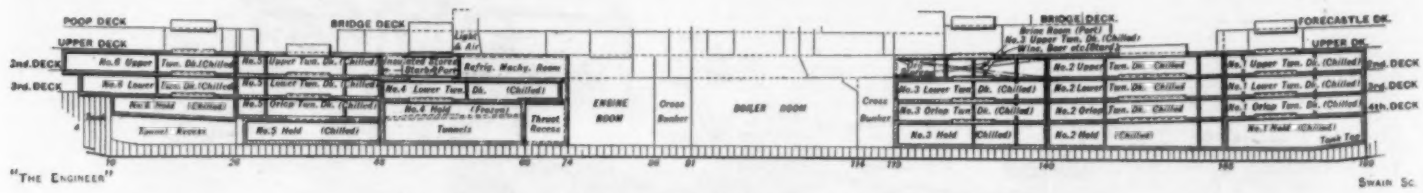


FIG. 1—PROFILE OF SHIP SHOWING ARRANGEMENT OF INSULATED SPACES

The Panel System.

The outstanding feature of the panel system is that each frame and beam space is insulated in such a manner that it is entirely independent of the adjoining spaces. Standard sizes of wood grounds are employed throughout the ship. In Fig. 2 we show one method of attaching the grounds and panels to the side frames. In the arrangement illustrated an angle lug is employed, and is attached directly to the bulkhead or to the bulb angle stiffener. The lugs are of just sufficient width to allow the bolts to be worked clear of each other. They are further provided with slotted holes so that a certain amount of adjustment is possible when fixing the wood grounds. It will be seen that the inner edge of each ground extends into the cargo space and is thus ventilated. Tongued and grooved panels are fitted between the grounds in a groove at one end and against a shoulder at the other, and they are secured in position by a capping piece so that no nails are driven through the panels. It is claimed for the system that the grounds and panels so fixed do not become subject to dry rot, such as might possibly occur with a totally enclosed ground, while they are kept under observation and are very easy to renew, should that be necessary at any time. Moreover, the panels are quite portable and are quickly removed when it is desired to examine the air, sounding, scupper and brine pipes, which are fitted behind the insulation.

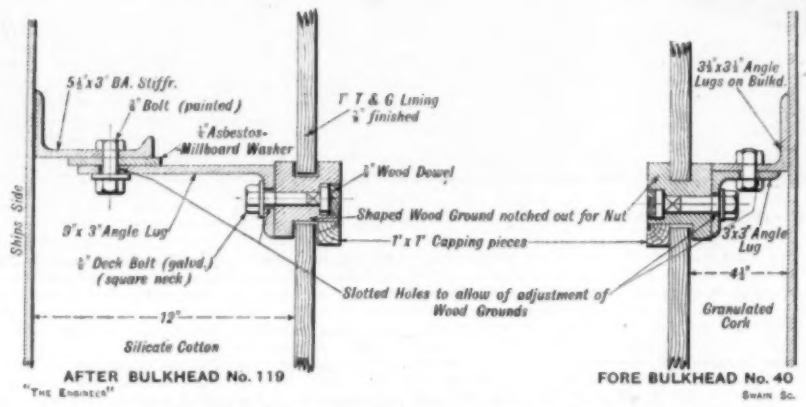


FIG. 2—METHOD OF ATTACHING WOOD GROUNDS TO SIDE FRAMES

The drawings—Fig. 3—show the arrangement of the roof supports in the chilled meat spaces and the frozen meat holds respectively. In the first case stout galvanised hanger bolts which pass through the webs of the deck stiffening channels are employed. In the chilled meat spaces nuts are provided on alternate hangers for supporting the wood grounds which are drilled to template and assembled in position very rapidly. A lower nut serves to grip the clip, which holds the brine pipes and the meat rails. In the frozen meat holds a flat bar clips the brine pipes, and use is made of short wooden chocks through which the bolts supporting the wood grounds pass. It will be seen that in all cases insulating washers, cork slab pads, and bushes are fitted, so that the brine pipes cannot come into contact with the ship's structure. For the same reason the heads of the deck bolts in the wood grounds—shown in Fig. 2—are protected by wood dowels let into the surface of the grounds. The two lower views—reproduced on page 378—show the arrangement of brine-cooling pipes and meat rails in one of the 'tween deck chambers and No. 4 lower hold. Around each hatchway in the 'tween deck spaces there are insulated trunkways fitted with insulated doors, which give access to the various chambers. Such an arrangement permits any of the main chambers to be loaded or unloaded separately without having to interfere with the chamber either above or below.

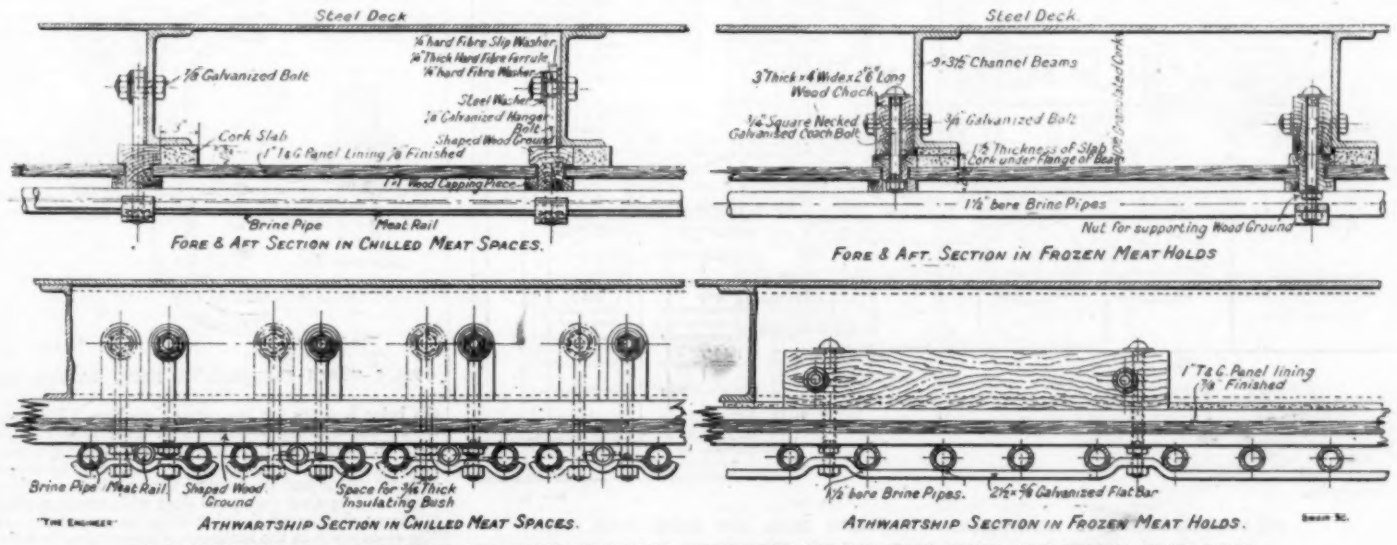

Steel Deck
⅛" hard Fibre Slip Washer
⅜" Thick Hard Fibre ferrule
¼" hard Fibre Washer
⅛" Galvanized Bolt
Steel Washer
⅞" Galvanized Hanger Bolt
Cork Slab
Shaped Wood Ground
1" T & G Panel Lining ⅞" Finished
1"x1" Wood Capping Piece
Brine Pipe
Meat Rail
FORE & AFT SECTION IN CHILLED MEAT SPACES.
Steel Deck
9-3½" Channel Beams
3" Thick x 4" Wide x 2'6" Long Wood Chock
½" Square Necked Galvanised Coach Bolt
¾" Galvanized Bolt
1½" Thickness of Slab Cork under Flange of Beam
1½" bore Brine Pipes
Nut for supporting Wood Ground
FORE & AFT SECTION IN FROZEN MEAT HOLDS
Brine Pipe
Meat Rail
Shaped Wood Ground
Space for ⅜" Thick Insulating Bush
ATHWARTSHIP SECTION IN CHILLED MEAT SPACES.
1" T & G Panel lining ⅞" Finished
1½" bore Brine Pipes.
2½"x⅜" Galvanized Flat Bar
ATHWARTSHIP SECTION IN FROZEN MEAT HOLDS.
"THE ENGINEER"
SWAIN Sc.

FIG. 3—ARRANGEMENT OF INSULATION AND BRINE PIPE ROOF SUPPORTS IN CHILLED MEAT SPACES AND FROZEN MEAT HOLDS

The Refrigerating Machinery.

The refrigerating machinery is all steam driven with the exception of the water and brine-circulating pumps, which are of the centrifugal type, and are direct-coupled to electric motors. It works on the carbonic anhydride closed system, and with it brine at four different temperatures may be circulated through the cooling pipes, which are arranged in the various insulated chambers, as shown in the two lower views on page 378. As will be seen from the drawing of the ship—Fig. 1—the main machinery is housed on the second deck immediately abaft of the main engine-room. Part of the main refrigerating machinery room is divided off to form a brine distribution room for the whole of the after chambers in the ship, while six large steel mains are carried forward from this room to a brine distributing and control room for the forward chambers in the ship, which is situated on the port side of the second deck forward of the boiler-room and cross bunker.

The plant is installed in duplicate, and is so designed that each set of machinery is capable of maintaining the necessary temperatures throughout the ship, even when she is steaming at sea fully loaded, and under tropical weather conditions. It comprises the following main items:—Two refrigerating machines, each consisting of a tandem compound steam engine driving from its tail rod a CO_2 gas compressor, two independent CO_2 gas condensers, two evaporators or brine coolers, five brine circulating pumps, two smaller pumps for the provision circuits, and a brine heater. In what follows a more detailed description of these various machines is given.

The two refrigerating machines, one of which is illustrated in Fig. 4, are placed athwartships. They are widely spaced—see the left-hand upper view on page 378—so that access is given on all sides. Each unit comprises a compound steam engine with cylinders 14in. and 26in. and a stroke of 21in., which is coupled through a tail rod and slipper guide to the CO_2 gas compressor with a cylinder diameter of 7½in. running at a normal speed of about 70 revolutions per minute. As will be seen from the aforementioned illustrations, the cylinders are mounted on a robust box pattern bed-plate which is jointed at the middle,

ship has a total insulated cargo capacity of about 450,000 cubic feet, to which 5600 cubic feet of insulated provision chambers must be added. The work of fitting the wood linings to the chambers and applying the granulated and slab cork was carried out by the builders of the Almeda, Cammell Laird and Co., Ltd., of Birkenhead. The refrigerating machinery, brine piping, meat rails, hooks, &c., were supplied by the Liverpool Refrigeration Company, Ltd., of Colonial House, Water-street, Liverpool, all the machinery being constructed at the firm's Coalbrookdale Works, Salop, and the brine piping, coals, condensers, and

REFRIGERATING MACHINERY ON THE BLUE STAR LINER ALMEDA

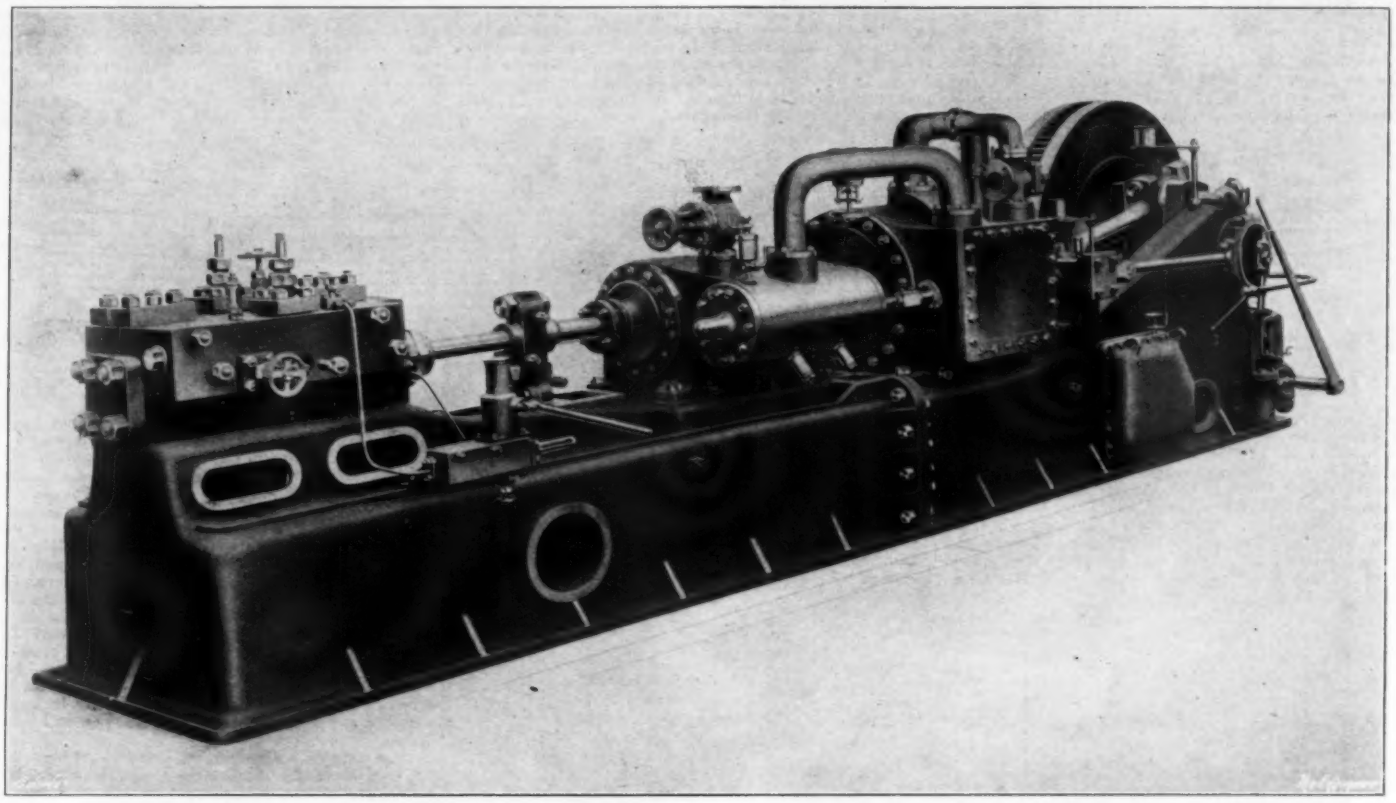


FIG. 4—TANDEM-COMPOUND STEAM-DRIVEN CO_2 COMPRESSOR

the front half carrying the low-pressure cylinder and main crank shaft bearing, whilst the rear half forms a rigid stool for the high-pressure steam cylinder and gas compressing cylinder with the intermediate slipper guide. Beneath the crank-pit in the forward part of the bed-plate a surface condenser is arranged and the air pump and feed pump are driven direct from the crank shaft. The crank shaft is of the slab type, and carries a heavy disc fly-wheel provided on its periphery with teeth for the hand-operated barring gear. The engine is designed to work with the full working steam pressure of 200 lb. per square inch, but more usually a reduced pressure of about 120 lb. is employed, a special reducing valve being fitted for this purpose. We may perhaps remark upon the substantial nature of the compressor cylinder block and valve covers, which are made from solid high carbon steel forgings and are shown in the left upper view, page 378. The compressor piston is fitted with metallic packing, and the packing, which is of the "Regulator" type, is also fitted to the gas glands of the compressor and the steam glands of the engine. Each compressor is designed for an output which is equal to the elimination of 750,000 B.Th.Us. per hour when it is running at full speed, this figure being based on a condenser temperature of 86 deg. Fah. and an evaporator temperature of 5 deg. Fah. At the side of the two machines there are arranged the two CO_2 gas condensers, which are independent of each other. Each of them is furnished with sixteen concentric coils of solid drawn copper tube contained in a heavy cast iron casing with a circular crowned top. The casing is made in halves to facilitate the easy inspection and removal of the coils. Other machinery in the main room comprises a vertical duplex steam-driven brine circulating pump for the cargo cooling chambers and a small steam driven duplex-pump for circulating brine through the various cold cabinets fitted throughout the ship. These pumps are so arranged, as regards their valve and pipe connections, that they can be worked interchangeably with the main pumps—which are electrically operated—for each service. As shown in Fig. 5, the motors driving these five pumps are placed in the main machinery room, but the pumps are placed on the other side of the insulated bulkhead which divides off the brine distributing room. The brine pumps, one for the cold cabinets and four for cargo use, are grouped along the fore and aft bulkhead and are of the centrifugal type. They were supplied by Gwynnes Ltd. The combined duty of the five cargo brine pumps, one steam and four motor driven, is 120,000 gallons of brine per hour, while that of the two cooling cabinet pumps, one steam and one motor driven, is 7000 gallons of brine per hour. Two other pumps which are not shown in the drawing are the motor-driven water-circulating pumps for the refrigerating plant, which are fitted in the main engine-room. They have a combined duty of 60,000 gallons of water per hour.

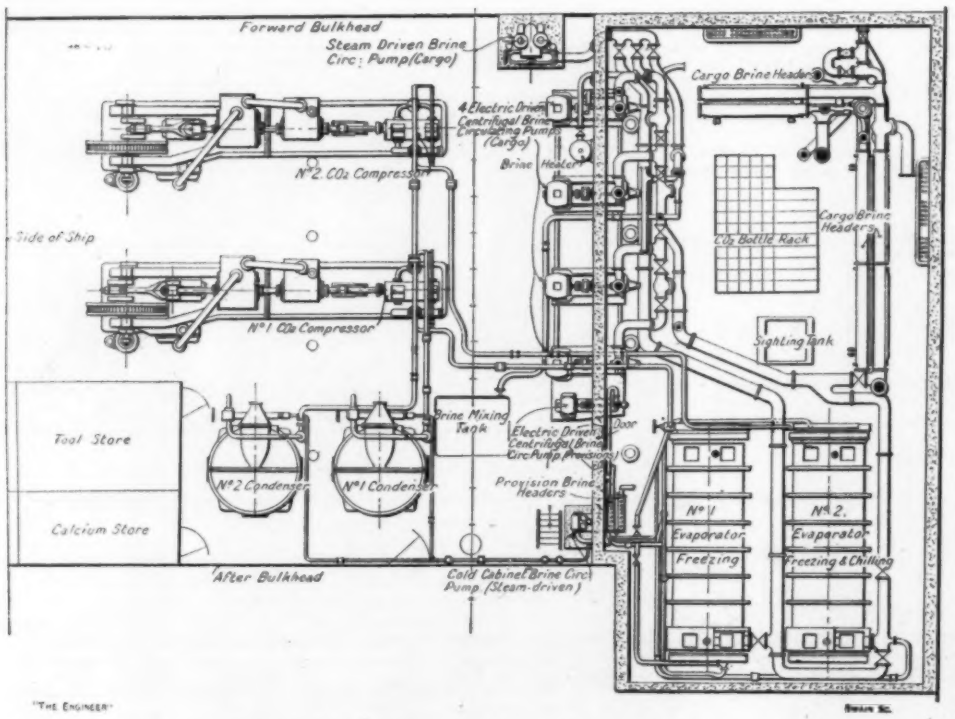


FIG. 5—ARRANGEMENT OF REFRIGERATING MACHINERY ROOM AND BRINE ROOM

In the brine distribution room are installed the two CO_2 evaporators or brine coolers. The cooling surface is provided by a number of oval coils of solid drawn steel tubing, all of the same length and conveniently arranged for removal when necessary for inspection. The casings of the evaporators are built up of steel plates in rectangular form, the plates being strongly reinforced with bulb angle stiffeners. Each evaporator is so arranged that the brine to be cooled makes two passes through it. Along the forward bulkhead and at the side of the ship are placed the brine headers for the cargo chambers. This part of the installation may be clearly seen in the upper right-hand view on page 378, which not only shows the grouping of the control cocks on the headers but also other arrangement of brine mains and the control valves which are fitted to enable the several pumps to deal with freezing, chilling, auxiliary chilling or thawing brine as may be required. The main space in the forefront of the sections is reserved, as indicated in Fig. 5, for CO_2 bottle storage racks about 100 flasks of CO_2 being carried. We need but briefly refer to the CO_2 charging apparatus, the regulating and stop valves and the intermediate piping which completes the CO_2 gas circuit. Other equipment in the brine room includes the necessary outfit of scale traps, oil traps, CO_2 driers, and sighting tanks. In the main machinery room there is a brine mixing tank and a brine heater.

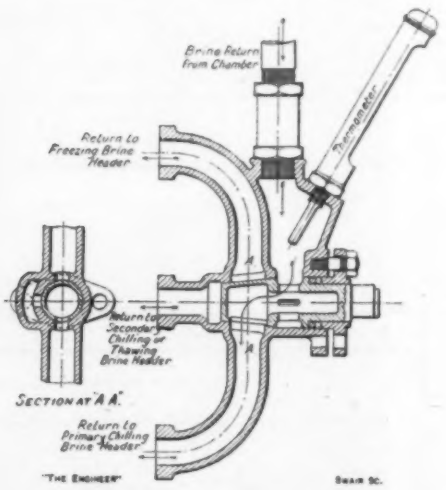

Brine Return from Chamber
Thermometer
Return to Freezing Brine Header
Return to Secondary Chilling or Thawing Brine Header
Section at A A
Return to Primary Chilling Brine Header
"The Engineer"

FIG. 6—THREE-TEMPERATURE BRINE RETURN COCK

Equipment of Cold Chambers.

The two lower views, which are given on page 378, serve to indicate the general arrangement of the cold brine piping in the holds and 'tween deck spaces. Our illustrations

show one of the 'tween deck spaces and No. 4 lower hold which is reserved for frozen cargo. The brine piping has a 1¼in. diameter bore and is formed of solid drawn tubing of soft mild steel, which, as far as possible, is bent and electrically welded to form continuous grids. As shown, these grids are fitted and arranged overhead and on all walls of the chambers and round the hatch trunkways. In all there are about 160 separate sections, or brine circuits, so grouped and interlaced as to ensure an accurate and even control of temperatures throughout all the insulated spaces in the ship. As already mentioned, the controls are divided into two groups. Those for the forward chambers are fixed in the forward brine control room on No. 3 upper 'tween deck—see Fig. 1—while the controls for the after chamber are situated in the brine distribution room—illustrated in Fig. 5. With the exception of No. 4 lower hold all the cold chambers are provided with overhead tubular steel meat rails which, as shown on page 378, are carried right fore and aft. They are pitched at 12in. centres and care is taken not to lose any available hanging space throughout the ship. In the way of hatchways special portable meat rails and removable cooling grids are fitted. Fig. 3 shows the method of fastening the meat rails. Sliding hooks are threaded in place on the rails, before they are fitted in position, and take the galvanised steel chains, which are employed to suspend the lower tiers of fore-quarters of beef. The whole of the equipment of piping rails and supports is heavily galvanised.

It is of interest to learn that the total length of the brine piping which is fitted for cooling the cargo, is approximately 37 miles, while over 12 miles of meat rails are fitted with about 75,000 sliding meat hooks.

The Brine Distribution System.

The system of brine distribution employed has been specially designed for the carriage of chilled beef, which, during the period of transport, requires to be very accurately maintained at a temperature just above the actual freezing point of the meat. In the latest practice a full head of brine is circulated through the cooling pipes, but it is attemperated to the desired temperature, the cooling surfaces being sufficiently large to allow the temperature of the brine to be carried within a very few degrees of the actual temperature of the meat. It will be understood that the brine which is used for the holds loaded with frozen cargo is much too cold to serve this purpose, and for chilled beef cargo attemperated brine at suitably higher temperatures is therefore employed. From the section—given in Fig. 1—it will be observed that the upper 'tween deck spaces are more or less exposed to the sun's rays, and although special care is taken with regard to the deck insulation, they require more refrigeration and a lower brine temperature than do the chambers below the water line, which have other cold chambers above them. In order to meet this and other conditions, the installation we are describing makes provision for the circulation of brine in the 160 different circuits at four different temperatures. They may be summarised with their differing purposes as follows:—

"Freezing brine": For chambers loaded with frozen goods.

"Chilling brine": At any suitable higher temperature for chambers loaded with chilled meat and other goods.

"Auxiliary chilling brine": At any desired second higher temperature for the above named purposes.

"Thawing brine": For thawing down the chambers after the cargo has been discharged.

As the "thawing brine" is not required during the voyage, but only when in port, it is circulated through the mains, which are provided for the "auxiliary chilling brine." The "freezing brine" is cooled directly in the evaporators, while that for "chilling" and "auxiliary chilling" is cooled by attemperation, or mixing with it sufficient "freezing brine" to reduce the temperature of the "chilling brine" to that desired. Special mixing valves are provided and the "chilling brine" is circulated continuously with sufficient "freezing brine" injected into it to maintain the required temperature. Overflow circuits are provided through which any excess of "chilling brine" is automatically returned to the evaporator. The brine connections are also so arranged that when loading chilled beef under hot weather conditions, the chilling brine can be passed direct through one of the evaporators and refrigerated in it. The high CO_2 back pressure created in the coils of the evaporator which is so connected, results in a bigger output being obtained from the machine. The brine can, if required, be further cooled by injecting "freezing brine" from the other machine which works at a much lower CO_2 back pressure and temperature. Such an arrangement does, of course, involve the two machines being run at the same time.

Fig. 6 shows the firm's patented three temperature brine cock which is fitted both on the inlet and return pipes of each section, so that either "freezing," "chilling" or "auxiliary chilling brine" can be circulated independently through any of the 160 brine circuits by simply setting the cock in the position required. The drawing given shows a single return cock with the thermometer pocket, and the same construction is applied for the duplex cocks on the feed and return systems. The brine which is circulated on the entirely closed system is delivered by the pumps to multiple branch headers for "freezing," "chilling" and "auxiliary chilling." To these headers are attached the multiple branch cocks already referred to and illustrated in Figs. 4 and the upper right-hand view on page 378. There is one cock for each section of brine piping, and by setting this cock, connection is made between the cold chamber brine circuit and the particular supply header from which it is desired to take the brine, which flows through the cock outlet through service pipes leading to the cold chamber circuits. After circulating in the cold chambers the brine is taken back through other service pipes to the return or collecting headers, which, as our illustration shows, are situated above and slightly behind the feed headers. The cocks on these headers are set to conform to the positions of those on the supply headers. The three temperature cocks are arranged in pairs right and left hand which, for easy identification, are painted with different colours for each pair. Different colours are also used for painting the mains, so that the various brine pipe systems are readily distinguished one from the other. "Freezing" brine is returned directly to the evaporators for re-cooling, while "chilling" and "auxiliary chilling" brine is taken back to the pumps for re-circulation, arrangements for the injection of "freezing" brine and for overflow being made as already described.

Although an entirely closed system of circulation is employed test headers are provided with suitable valves and connections to enable each brine circuit return to be directed into a small open topped tank and sighted so that the actual flow in any part of the system can be ascertained and checked. Brine drawn off into the sighting tank is again returned to the brine system. In order to accommodate the increased volume of brine created during the thawing off of cargo a tank of sufficient capacity is arranged at the highest part of the brine system. It is furnished with a gauge glass and a constant brine level is kept in it, so that the system is always full. This gauge also gives prompt indication in case of any leak taking place in the brine system. A brine pressure gauge is fitted at each end of the header, so that the pressure can be regulated by valves in different parts of the brine system.

Test Results.

The usual temperature test trials for the refrigerating plant of the Almeda were carried out at Tilbury on Monday and Tuesday, December 13th and 14th last. After a preliminary run the real trials were begun at 11 o'clock on Monday, and the machines were run through to the conclusion of the test about 6 o'clock on the evening of Tuesday. During this period the temperatures in the holds were reduced to a mean of about 10 deg. After shutting down the machines, the temperature rise was noted between 6.30 p.m. on Tuesday and 6.30 a.m. on Wednesday morning, December 15th. The mean rise in the temperature of the chamber was a little more than 6 deg., which is very small. Since the test was made the Almeda has made several successful voyages, and the working of the plant under actual conditions of loading, transporting and unloading has been tested with every satisfaction. Refrigerating installations designed on similar lines have been installed in the two sister passenger liners built for the same owners by Cammell Laird and Co., Ltd., at Birkenhead in two passenger liners built by John Brown and Co., Ltd., at Clydebank, and in two cargo steamers which have been constructed, by Messrs. Palmers and Lithgows, Ltd., respectively.

In conclusion, we have to express our thanks to Mr. E. A. Thomson, the senior superintendent of the Blue Star Line (1920), Ltd., for the assistance he has given us in the preparation of this article, and to the owners and the builders of the ship, and refrigerating machinery, for the facilities placed at our disposal for inspecting the installation.

A New Light Steam Locomotive.

We recently had an opportunity of inspecting a new type of light locomotive, evolved by Clayton Wagons, Ltd., of Abbey Works, Lincoln, which is illustrated by the drawings and engravings below.

The engine is really an adaptation of the Clayton steam wagon to railway practice in the way of a shunting locomotive, chiefly with the objects of securing a high ratio of tractive effort to weight and of reducing coal consumption. Both these results are the natural outcome of the adoption of a high-speed engine, coupled with the driving wheels through reduction gearing and the use of a high-pressure boiler. The high speed of the crank shaft and the gearing smooth out variations in the torque at the driving axle, as compared with normal locomotive practice, and consequently there is less liability for the wheels to slip, so that the adhesive weight is more effectively utilised, while the use of high-pressure steam naturally tends towards economy.

The general arrangement of the machine can be followed in the line drawing, Fig. 1, from which it will be seen that it is a four-coupled locomotive with inside axle-boxes.

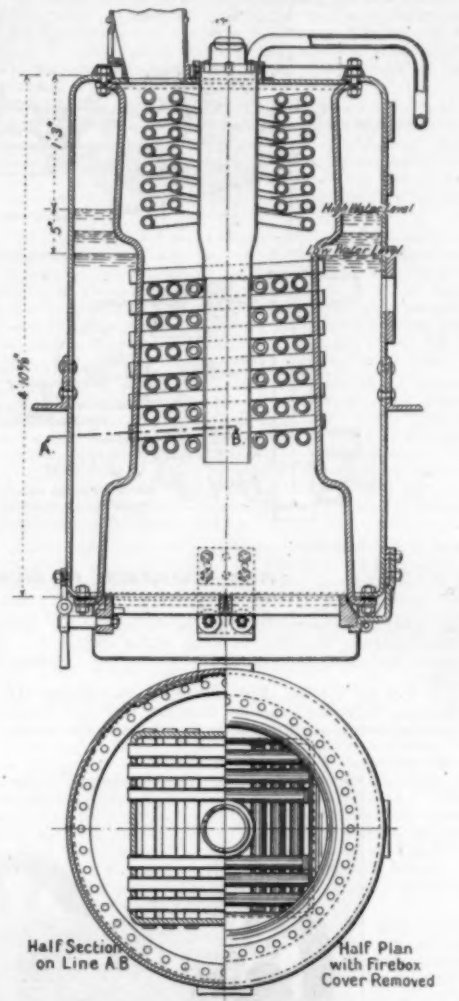


FIG. 2—THE BOILER

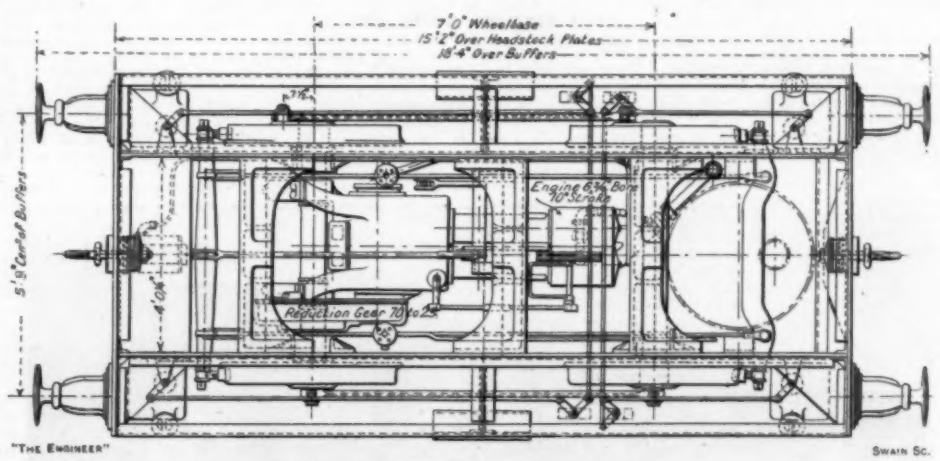


FIG. 1—PLAN OF CLAYTON LIGHT STEAM LOCOMOTIVE

The side frames are steel plates ⅜in. in thickness, while the cross bearers are heavy iron castings machined where they are bolted to the frame plates. The result is a very substantial framing, which provides the weight necessary for adhesion.

Coming now to the motive machinery, the boiler and the engine are distinct units, either of which can be removed without disturbing the other. The boiler—see Fig. 2—is of the vertical type, with water tubes slightly inclined from the horizontal, and is fired through a central shoot from the top. The shoot, it will be noticed, has the lower portion, which is more liable to be burned away, so arranged that it can be easily renewed when necessary. The inner shell or fire-box is attached to the outer shell by means of two machined flanges, with intervening asbestos joints, and bolts, so that it can be dropped down through the bottom for the scaling of the heating surfaces. The whole business of dismantling the boiler, scaling it, and re-erection can be done, we are told, within eight hours. In the top of the fire-box there is a coil for superheating the steam. The fire-grate is made in two halves and is hinged at the centre, so that it can be dropped for clinkering purposes, while the ash-pan is also hinged and thus can be used as a damper to regulate the draught through the fire. The feed water is supplied either by a direct-acting pump in the cab or by an injector and can be warmed up by means of the exhaust steam from the engine. The remainder of the exhaust is, of course, sent up the chimney to increase the draught through the furnace. The fittings include two safety valves. The boiler is worked at a pressure of 275 lb. per square inch and the steam is supplied at a temperature of about 600 deg. Fah. It is designed to comply with the Board of Trade rules, and for each boiler a certificate of the Manchester Steam Users' Association is obtained.

The engine is of the two-cylinder high-pressure type, with cylinders 6½in. diameter by 10in. stroke, and its general design is illustrated by the line drawing Fig. 3, while its exterior appearance is well shown in Fig. 4. The engine crank cases and the gear-box of the reduction gearing are bolted together so as to form one unit, and the combined set is supported at the gear end by bearings surrounding the main driving axle, while the other end is carried by a swinging link attached to one of the cross bearers of the main framing. This link, which is shown

above the crosshead guides in Fig. 3, is arranged in such a position that it carries the greater part of the weight of the engine, which is consequently spring-borne. It might be said, in fact, that the only unsprung "weight" in this part is the moment of inertia of the engine about the supporting link. Incidentally it will be noticed that the link is provided with spherical washers and rubber buffers.

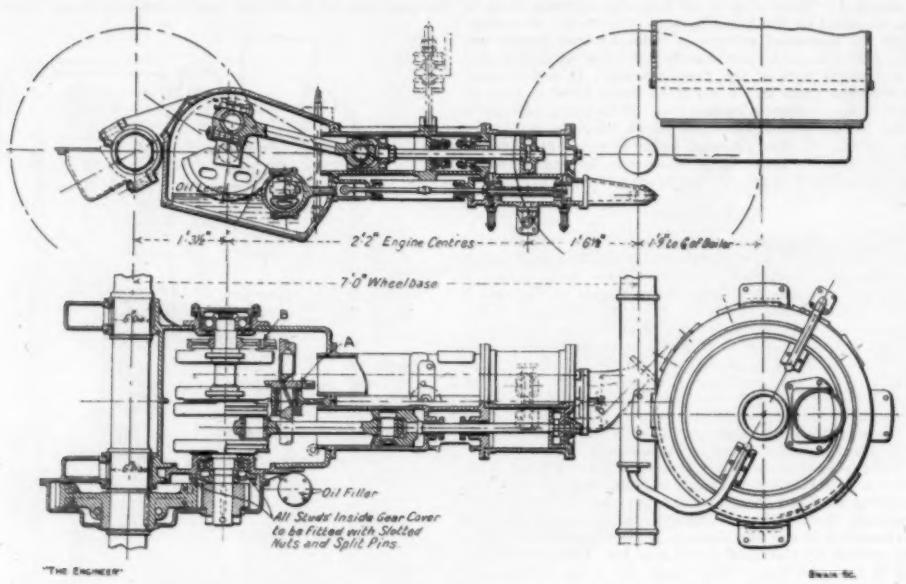


FIG. 3—ARRANGEMENT OF ENGINE FOR CLAYTON STEAM LOCOMOTIVE

In order to accommodate any movement of the engine, with regard to the main framing, as the springs flex, the steam pipe connections are made by means of "Flexsteel" joints.

It will be noticed that the engine has piston valves arranged below the cylinders to ensure thorough drainage, and that it is generally of orthodox design. The reversing gear is, however, rather interesting. There are only two excentrics, one for each cylinder, and they are mounted on a lay shaft driven off the crank shaft by gear wheels. It should be noted that only one of the excentrics is shown, at A, in the plan view of Fig. 3, and that although there appears to be a ratio between the two gear wheels B, on account of their difference in level, the two shafts run at the same speed.

In order to reverse the engine the excentrics are moved across the shaft from one side to the other, as shown in Fig. 5, from which it will be seen that the lay shaft is hollow and contains a sliding shaft, in which notches are cut to form two inclined planes at right angles to one another—one for each excentric. Engaging with each of these planes there are two pads which bear against the sides of a square hole cut through the excentric sheave. By moving the sliding shaft endways the excentricity can be varied from full ahead to full astern, and it will be noticed that the plane of sliding is so chosen that the angle of advance is the same in either direction, so that the cut-off is equal whether the engine is running forwards or backwards.

Another small detail, which would be described as the "regulator" in locomotive parlance, but would be called the "stop valve" by high-speed people, is illustrated by Fig. 7. It will be seen that the valve has to be opened, upwards, against the steam pressure, but that the effort necessary to do so is minimised by the extension of the valve as a piston into a recess, which is open to the atmosphere above. The result is that the resistance to opening is only that due to the difference in the diameters of the piston and the seating of the valve itself, while a corresponding resistance to closing is produced by another piston-like extension of the valve below. As a consequence the valve has a definite tendency to take up either position—open or closed—according to which way it is started deliberately, and there is little fear that a jolt may disturb the driver's control. At the same time the effort he need exert on either the regulator handle or, for the matter of fact, the reverse lever, is, as we had an opportunity of testing for ourselves, quite reasonable.

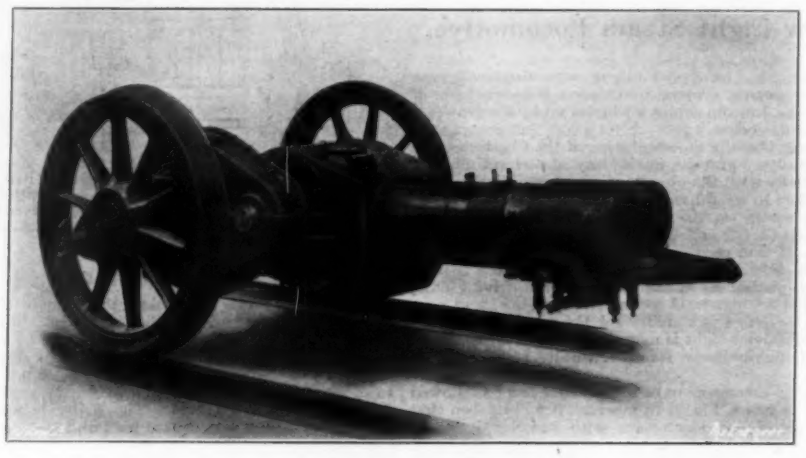


FIG. 4—COMPLETE ENGINE UNIT

FIG. 5—LOCOMOTIVE HAULING THE TEST TRAIN

A noteworthy feature of the engine is the care with which the plating of the cab and tanks has been executed. It is all of ½in. plate and at the tank end actually forms the tank. That is to say, it is not a light cleading to cover a separate tank. The edges of all the plates are planed, and although we saw the engine before it was painted, there was no perceptible gap between the plates at the various corners. The corners are, of course, made with internal angles and are flush riveted. Above the water tank there is a coal bunker so arranged as to trim the coal forward to the door, while the tank manhole is of standard design, so that the locomotive can pick up water at any standpipe.

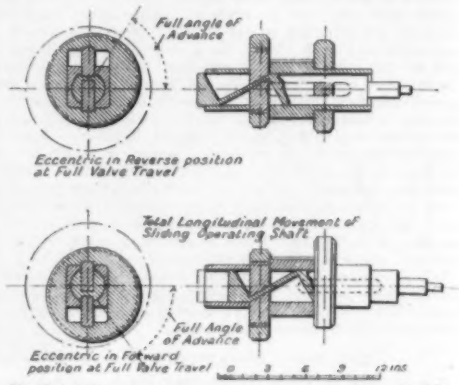

Full angle of Advance
Eccentric in Reverse position at Full Valve Travel
Total Longitudinal Movement of Sliding Operating Shaft
Full Angle of Advance
Eccentric in Forward position at Full Valve Travel
0 3 6 9 12 ins
"The Engineer"

FIG. 6—REVERSING GEAR

Inside the cab it is noteworthy that the driver has ample room to move about without tripping over any of the mechanism, and that the control levers are within easy reach even when he is leaning out of either of the side windows.

Below we give, in tabular form, the leading particulars of this engine:—

Gauge	4ft. 8½in.	
Two cylinders, each	6½in. dia. by 10in. stroke	
Boiler pressure	275 lb. per square inch	
Steam, superheated to	600 deg. Fah.	
Wheels	3ft. 6in. dia.	
	Gear ratio 3·04 to 1.	Gear ratio 3·9 to 1.
Speed at 360 r.p.m. of engine	14·8 m.p.h.	11·5 m.p.h.
Speed at 400 r.p.m. of engine	16·4 m.p.h.	12·8 m.p.h.
Speed at 500 r.p.m. of engine	20·5 m.p.h.	16 m.p.h.
Weight of locomotive (tank half full and coal bunker half full)	20 tons	22 tons
Maximum load pulled at 3 m.p.h.	288 tons	350 tons
Maximum load pulled at 5 m.p.h.	251 tons	305 tons
Maximum load pulled at 10 m.p.h.	170 tons	206 tons
Maximum load pulled at 15 m.p.h.	100 tons	121 tons
Time to raise steam from cold	1 hour	
Time to raise steam when warm	40 minutes	
Evaporation	9 lb. water per lb. of coal	
Steam consumption	18¼ lb. per brake horse-power per hour	

In connection with Fig. 5, which shows a test load made up to demonstrate the hauling capacity of the engine, it will be seen that the rails rise abruptly to go over a level crossing. On the occasion of our visit, when the rails, certainly, were rather slippery, an ordinary shunting locomotive had the greatest difficulty in pushing three trucks over this hump, and although we did not have an opportunity of making a similar test with the new engine, we were assured by the makers that it could surmount the obstacle with a full load, a characteristic which can only be explained by the even torque transmitted to the driving wheels.

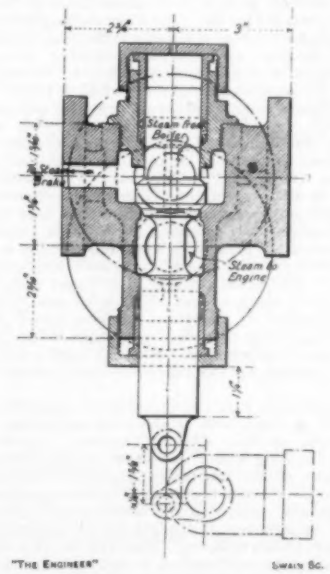


FIG. 7—THE REGULATOR

Included in some changes recently announced by the London and North-Eastern Railway is the transfer of Mr. C. F. Slade from the position of district engineer at Peterborough to that of district engineer at King's Cross, in place of the late Mr. F. R. Hurst.

Railway Matters.

THE former Great Northern engine No. 1 has been taken to York to be put in the Railway Museum there. It was built by Mr. "Pat" Stirling in 1869, and had outside cylinders and a single driving wheel of 8ft. diameter. No. 1 was one of the engines which took part in the procession of locomotives at Darlington on July 3rd, 1925, in commemoration of the centenary of railways.

THE Burmah Legislative Council has passed, without a division, a resolution to the effect that the best interests of the province were likely to be secured by the State management of its railways on the termination of the present contract. That time arrives next year, and Earl Winterton stated in the House recently that the Secretary for India was awaiting the recommendation of the Government of India on the subject.

WE regret to see the announcement of the death on the 27th ult. of Mr. W. T. Foxlee, who was for many years in the engineering department of the London and South-Western Railway. Of recent years, Mr. Foxlee was associated with light railways. A useful contribution of his to railway literature was the paper on "Railroad Terminals," contributed to the International Engineering Congress, organised in 1904 by the American Society of Civil Engineers.

THE appointment of a receiver and manager for the Welsh Highland Railways, mentioned on page 272 of our issue of March 11th, will not, announces Colonel H. F. Stephens, the chairman and managing director, interfere with the public services of the railway. Colonel Stephens, who now acts as receiver and manager, says that it is intended to give an effective service for the convenience of an increasing number of tourists who, it is hoped, will patronise the railway this season, and thereby enable it to overcome and remove the effects of the hard times through which it has recently passed.

THE annual reports of the four larger companies show that last year they spent over 3 million pounds out of revenue, and exclusive of any capital charges, on the purchases from outside sources of locomotives, carriages and wagons. The London, Midland and Scottish Company bought locomotives, £602,463; carriages, £814,315; wagons, £457,827. The London and North-Eastern: Locomotives, £62,855; carriages, £391,821; wagons, £284,032. The Great Western: Locomotives, £76,742; carriages, £22,239; wagons, £25,981. The Southern: Locomotives, £159,959; carriages, £23,760; wagons, £83,137.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first two months of the present year was as follows, the corresponding figures for 1926 and 1925 being added in brackets:—Locomotives, £142,309 (£851,642, £561,131); rails, £188,879 (£403,486, £371,156); carriages, £382,000 (£272,538, £346,849); wagons, £324,491 (£762,632, £531,181); wheels and axles, £58,055 (£88,707, £117,986); tires and axles, £51,523 (£54,403, £83,787); chairs and metal sleepers, £40,839 (£121,308, £60,072); miscellaneous permanent way, £182,043 (£174,666, £245,233); total permanent way, £521,339 (£842,570, £878,234). The weight of the rails exported was 16,034 tons (47,031 tons, 37,555 tons), and of the chairs and metal sleepers, 4666 tons (12,422 tons, 4472 tons).

THE greatly improved position of the Canadian National Railways last year, and the largely increased volume of traffic, have been followed by a policy of expansion. In addition to a programme for the construction of new branch lines, involving an expenditure of several million dollars, the sum of 1,660,000 dollars will be spent this year in the completion and extension of a number of partially constructed lines in the West, on which the sum of 13,000,000 dollars has already been expended. A large amount of new equipment has been ordered, including sixty-four locomotives, forty of which will be built in Canada by the Montreal Locomotive Works, Ltd., and the Canadian Locomotive Company, of Kingston, Ont.; and 1000 60-ton steel-frame box cars from the Canadian Car and Foundry Company, of Montreal, which company some little time ago also received a 2,000,000-dollar order for passenger cars.

THE gates of the crossing of the London and North-Eastern Railway over High-street in the city of Lincoln used to be worked by a gateman by hand. They have now been coupled to the signal-box and are operated electrically. Judging by a question asked the other day, the change has suggested "increased danger and delay" in the minds of some of the inhabitants. Colonel Ashley, in reply to the question, said that he was advised that the new method of operation was not more dangerous than the hand operation formerly in use, and he was afraid that at level crossings where the volume of traffic passing both by railway and by road is heavy, inconvenience must necessarily arise. When it was pointed out in a supplementary question that the construction of the Lincoln avoiding line, sanctioned in 1924, would relieve the situation, Colonel Ashley said that he had no power to require a railway company to construct a line that was authorised but not yet commenced.

THE Stationery Office has published the Preliminary Railway Returns for 1926, price 2s. They show that on the four grouped companies 1068 million passenger journeys were made, for which £54,500,000 were received, as compared with 1232 million journeys and £62,800,000 received in 1925, and that workmen's fares fell from £4,115,577 to £3,500,000. It is of interest to note that the receipts from parcels showed a decrease from £15,229,445 to only £14,700,000. In general merchandise the drop was from £50,109,106 to £46,000,000; from coal, coke and patent fuel, from £35,827,102 to £24,100,000; and from other minerals from £15,772,445 to £13,000,000. The total traffic receipts were £171,800,000, as against £199,652,875, and the corresponding reduction in expenditure was from £164,655,630 to £153,800,000. The ratio of expenditure to receipts was 90·4 as compared with 83·26—in 1913 it was 63·53. The passenger train mileage was reduced from 261,759,298 to 233,630,000, and the freight train mileage from 141,076,323 to 112,866,000.

Notes and Memoranda.

THE method worked out in the research laboratories of Robinson Bros., Ltd., and described by Mr. D. W. Parkes to the Birmingham Section of the Society of Chemical Industry recently, for the removal of phenolic products from the effluent liquors from the distillation of gasworks ammonia seems, says the *Chemical Trade Journal*, highly promising. It is noteworthy that this is an occasion when English chemical engineers have apparently succeeded where continental investigators have not met with great success.

A MARKED tendency toward producing larger tonnages of limestone by underground mining methods instead of by the old established quarrying practices is very evident in the United States. In the course of six months' time, during which the subject was investigated by the Government's Non-metallic Minerals Experiment Station, at New Brunswick, N.J., the number of underground limestone mining projects was doubled. Some of these limestone mines are quite large, the maximum daily production from a single mine being 3500 tons.

A NOVEL system of concrete construction is, according to *The Times*, being used at Cambridge for the erection of some thirty houses by the Cambridge Corporation. The walls of the houses are constructed of large slabs of concrete cast on horizontal wood platforms. The door and window frames are placed on the platforms and the walls cast round them. The walls are then placed in position in a few minutes by a specially designed crane, and it is claimed that at least one house a day can easily be erected. The casting of the walls is done by unskilled labour and no scaffolding is required.

THE *Iron Trade Review* states that the Bethlehem Steel Company recently completed and placed in service at its Bethlehem, Pa., plant an extraordinarily large ingot mould for casting ingots intended for use in making large forgings. This casting, as poured, weighed 387,590 lb., with a finished weight, after cleaning and removal of sinkhead, of 382,000 lb., or 191 short tons (2000 lb.). The length of the casting is 15½ft., with a width of 108in. measured across the corrugations at the top of the mould, and 97in. across the concave portions of the corrugations. The ingot produced from this mould weighed, with sinkhead, 247 tons.

AN exhibit has been arranged by the British Non-ferrous Metals Research Association, at the Science Museum, South Kensington, London, to afford some indication of the assistance given to British metal industries by the research and auxiliary services of the organisation. The exhibit is concerned chiefly with eight of the Association's researches, including wiped plumbers' joints, chosen from among eighteen major investigations at present in progress. The Exhibition is open daily, and literature descriptive of the material on view and of the other work being carried out by the Association may be obtained at the Science Museum or from the secretary, B.N.F.M.R.A., 71, Temple-row, Birmingham.

THE Canadian Province of Ontario has, it is claimed, still the finest and most valuable white and red pine in the world. The amount of white and red pine timber is estimated by the Minister of Lands and Forests at between 12,000,000,000ft. and 15,000,000,000ft., and at the present rate of consumption is sufficient to last for fifty years, without counting on new growth. For the last five years the forests of Ontario have had an average annual value of production in lumber, laths, shingles, and ties of approximately 37,500,000 dollars; pulp and paper, 66,642,000 dollars; pulpwood exported, 3,300,000 dollars; and fuel wood, 12,229,000 dollars; or a total of approximately 120,000,000 dollars annually.

IT is reported from Stockholm that successful results from a new electrical process of iron smelting—the so-called Flodin-Gustafsson method of extracting soft iron directly from iron ore—have been announced by Mr. Sjoegren, director of the Forsbacka Works. The new Swedish invention consists of a single process by which lumps of iron ore are electrically smelted and pure iron or steel is obtained ready for use. The method is still being improved and is expected to yield even better results in the future than hitherto. The application of the new method to the production of rustproof iron has been practically tested for eight months at Forsbacka, and it is said that rustproof iron can now be produced at the same price as ordinary iron.

UNTIL recently molybdenum was added to steel in the form of ferromolybdenum. At present, however, most of the molybdenum used in steel is, according to H. A. Doerner, of the American Bureau of Mines, added in the form of calcium molybdate; reduction and combination as alloy result from the contact of the molybdate with the molten steel. This change marks an important economy in the production of molybdenum alloys for the following reasons:—(1) Reduction to ferromolybdenum involves considerable loss of metal in the slag, whereas calcium molybdate may be made without appreciable loss; (2) to convert a concentrate to calcium molybdate costs much less than to reduce it to ferromolybdenum; (3) detrimental impurities are easily eliminated during the process of making calcium molybdate, thus making a wider variety of ores available as a source of molybdenum.

IN the course of an address given before the Engineers' Club of Philadelphia recently, Mr. A. G. Christie described several modern methods of using coal as fuel and incidentally mentioned the McEwen-Runge process, which strips the coal of its volatile matter before it is burned in furnaces. Two large retorts are used, one above the other. The upper one has a certain amount of heated gas furnished to it, and the powdered coal is sprinkled down through it. As it falls through this upper retort it is raised in temperature to such a point that it loses its coking property, but does not give off gas. It will no longer stick together and swell into large masses of coke. Then it is dropped through another feeder into the lower retort, where it showers down through a very hot stream of gas, which distils off the gas and tars. At the bottom it is a char somewhat larger than it started as, but very friable. This material can be used as pulverised fuel under the boilers.

Miscellanea.

ACCORDING to *Halleschen Nachrichten*, the I. G. Farbenindustrie Akt.-Ges. will start the commercial production of oil by the hydrogenation of brown coal during April. The plant is at Leuna and the preliminary output will be small.

A LARGE sum is to be spent on Vizagapatam Harbour, India, with a view to turning it into a transhipment port for manganese ore with modern appliances. Work is to be commenced shortly. The harbour is to handle 140,000 tons of manganese ore and 250,000 tons of coal per annum.

ONE of the blast-furnaces at the Earl of Dudley's New Level Works, Brierley Hill, which has been idle for several years, is now being blown in, while the Palmer Shipbuilding Company at Jarrow-on-Tyne has restarted two of its five blast-furnaces. The whole of the latter plant had been idle since the miners' strike in 1921, except that two furnaces worked for four months in 1923.

A BATTERY of twenty coke ovens of the Simon-Carves regenerative type is to be put up at the New Monckton Collieries, near Barnsley, of the Monckton Coke and Chemical Company. The ovens will be built of high-silica bricks which permit of considerably higher temperatures being employed in the carbonisation process than is usual with ovens constructed of fire-clay bricks, which have until recently been generally used in this country.

THE Chapel, Whaley Bridge and District Gas Company has, according to the *Chemical Trades Journal*, placed with Koppers Coke Oven Company, Ltd., of Sheffield, an order for the first installation of Koppers continuous vertical chamber ovens to be erected in this country. The installation will consist of two units, each of two chambers. Each chamber will deal with 12½ tons of coal per day. The ovens are heated by producer gas, generated in outside producers of the Koppers type.

ONE of the most unique shipments of ore ever to leave Manitoba was, according to *Canada*, made recently, when 20 long tons of spodumene lithium ore started on its way to Germany. It will be used for experimental purposes in the manufacture of dyestuffs. If the experiments prove successful, the ore will be sent out in regular shipments. The spodumene came from deposits on the Winnipeg River, a few miles above Pointe du Bois. Considerable quantities of lithium minerals—spodumene, lepidolite and amblygonite—have been found in Manitoba recently.

THE Ontario Government is devoting much attention to the improvement of the highways and is preparing for an active season of road construction. Contracts representing a total value of 3,000,000 dollars, concerning all sections of the Province, have been awarded. They represent the principal part of the Government's road construction programme for the season, but some supplementary awards will be made later. Road construction has been greatly stimulated by the increased volume of tourist traffic, which has grown to be a factor of much commercial importance.

ACCORDING to the *Iron and Coal Trades Review*, the South Russian Steel Works proposes to erect a tube mill, which, when finished, will be one of the largest mills of this description in Europe. In addition to the tube mill, a steel plant is in process of erection, and will probably be completed in about two years. The equipment has been purchased in Czecho-Slovakia and Germany, which two countries have furnished the machinery for the tube mill. The capacity of the steel plant will be about 75,000 tons a year. Hitherto, all pipes and tubes used in the oil-fields of the Caucasus have been imported.

CONSIDERABLE extensions of the Canadian provincial hydro-electric system will be made this year, the amount included in the estimates submitted to the Legislature for that purpose being 14,970,000 dollars. The Niagara Falls system will require 9,345,000 dollars. Several of the leading centres of Ontario will be supplied with increased transformer capacity. The construction of transmission and distributing lines will cost 7,225,000 dollars, the principal item being a 220,000-volt line to Eastern Ontario. The sum of 4,045,000 dollars is required for the Thunder Bay development now under construction. Bonuses for rural transmission lines are on a more liberal scale than formerly, a vote of 750,000 dollars being asked for this purpose.

ADDRESSING the Canadian Problems Club at Vancouver recently, Dr. Adam Shortt, C.M.G., lately Commissioner of the Civil Service at Ottawa, and a well-known Canadian educationist and publicist, discussed the prospects of Canada. Referring to the vast strides made by the mining industry, Dr. Shortt stated that the apparently useless masses of rock which comprised the Laurentians probably held from one-half to two-thirds of the precious metals of the world and Canada was fortunate in the accessibility and concentrated form of these as compared to the gold of the Rand, scattered and costly to obtain. He had little doubt Canada would eventually be the world's greatest source of gold, platinum and silver, and within two years would be in second place as producer of gold.

IT is announced that the West Kootenay Power and Light Company has started preliminary development work on its new generating station at Slocan Rapids on the Kootenay River, British Colombia. The generating equipment will be supplied by the Canadian General Electric Company, Ltd., and will consist of three 17,500-kilovolt-ampère, 90 per cent. power factor, 100 r.p.m., 7200-volt, three-phase, 60-cycle, vertical, water-wheel driven generators, with direct connected exciters. The switching equipment will also be of Canadian General Electric Company manufacture. The three water wheels, which will be supplied by Canadian Allis-Chalmers, Ltd., will be of the vertical steel plate spiral cased type, the runners being specially designed to suit the operating conditions when, during the initial period of development, the head will vary from 70ft. to 80ft. The runners will be of the Francis type, and will be designed to develop 21,000 H.P. under the normal operating head of 70ft., and will also operate satisfactorily under a head of 80ft. At this higher head the capacity will be 25,000 H.P. per unit.

GLADSTONE DOCKS, LIVERPOOL

MR. THOMAS W. NEWELL, M. Inst. C.E., LIVERPOOL, ENGINEER

(*For description see page 373*)

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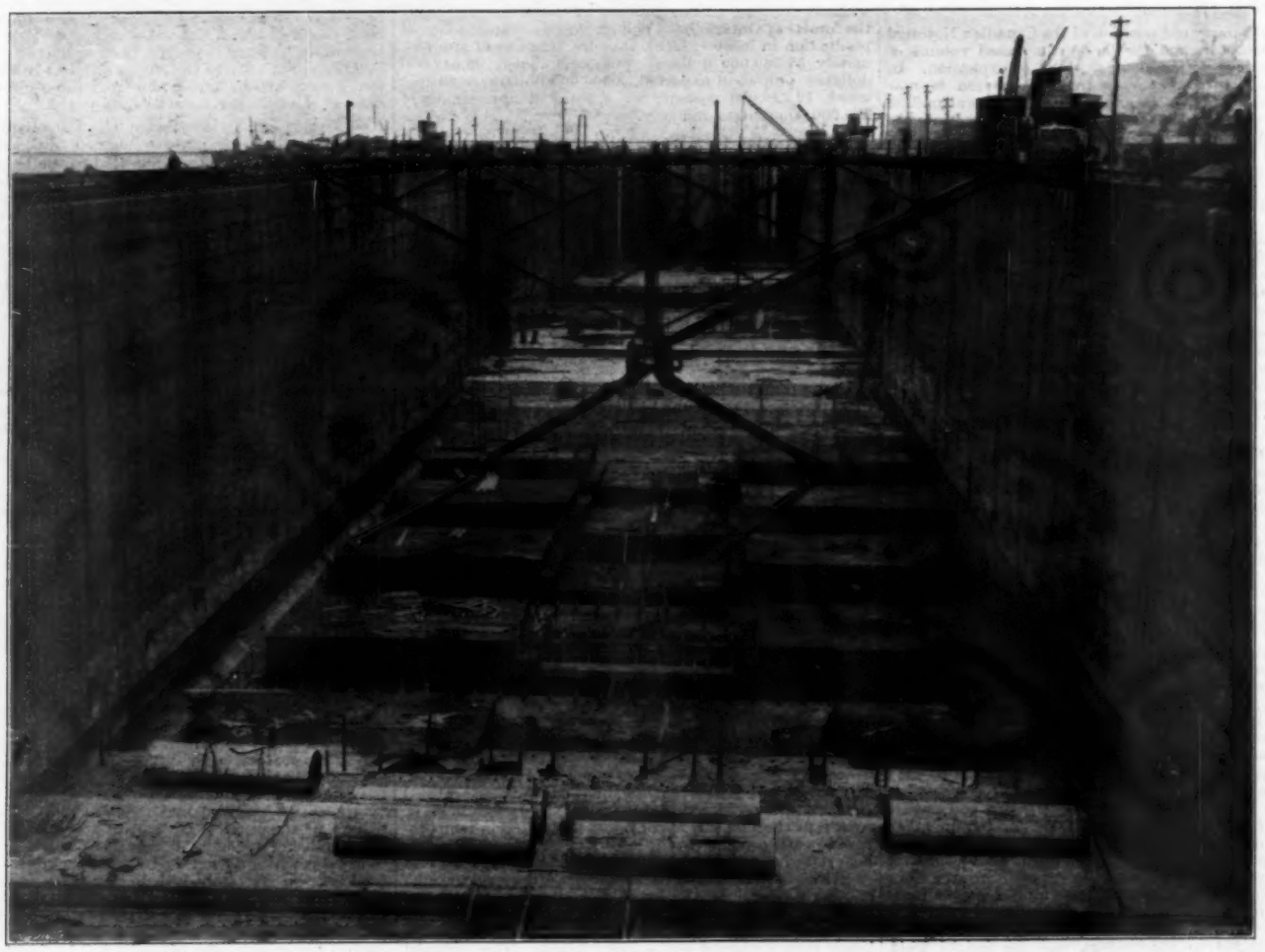

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THE ENGINEER.

APRIL 8, 1927.

The Trades Unions Bill.

NEARLY a year has passed since the Great Strike of 1926 opened. During that strike and for many months afterwards the Government was urged to take steps which would render its repetition impossible. The Cabinet wisely refused to be hurried into an action of which the results could not be clearly foreseen. It considered with care the varied proposals which were put forward by private individuals and by corporations and associations. It set up a Committee to survey the difficult questions involved. Nothing was done hastily; nothing was done in circumstances which would lay the Government open to the charge that it was acting with resentment. The Bill which it presented on Monday last may arouse the opposition of the Labour Party and of a section of trades unionists; it may fail to receive the full support of Conservatives; but it is impossible for anyone to say justly that it has been brought in with any other intention than the general welfare of the community. It is not a punitive measure. There is not a single clause in it which can honestly be construed as an attack upon trades unionism. Save in respect to their political activities, it interferes in no way with the internal organisation of trades unions; it does not even seek to remove the open ballot. In all that concerns their operation and management, with the single exception noticed, it leaves trades unions in just the position which they have secured through a succession of Acts of Parliament, as long as those privileges are exercised without injury to the convenience of the people of the realm or prejudice to the general welfare of industry. Within these limitations there is not a single clause in the Bill which weakens the position of the trades unions under the Act of 1906 in their dealings with employers, nor one that makes them more liable for torts committed in the cause of such dealings. All that the Bill seeks to do is to specify actions by a trade union which the law will not tolerate and to define clearly the meaning of that vague term "peaceful picketting." It must be observed, moreover, that it is nowhere proposed in the Bill that a union shall be liable for offences, save for the wrongful expulsion of one of its own members, it may be restrained from acting illegally, but the penalties which may be inflicted if such wrongful acts are performed are to be suffered by individuals, not by trades unions as corporate bodies. The Bill is designed for the protection of the community; it is in no sense retributive.

Regarding the measure in that light, and it is difficult to see in what other light it can be regarded, the opponents to the Bill must find themselves on the horns of a dilemma. They cannot persist in their objections to the principal clauses without avowing themselves, on the one hand, more interested in securing power to one section of the community than in assuring the welfare of the community as a whole, and, on the other hand, rather the champions of autocratic power than of that Liberty which they profess to pursue. For what is it that the Bill seeks to prevent them from doing? In the first section it declares that in certain circumstances strikes shall be illegal, and that if they are carried on, then the peculiar privileges accorded to trades unions by the Act of 1906 shall not apply. But the illegal strike is only that kind of strike which is "designed or calculated to coerce the Government, or to intimidate the community or any substantial portion of the community." Will any representative of Labour dare to affirm that the Act of 1906 meant to give immunity to trades unions if they provoked outbreaks of the kind here defined? Had Parliament foreseen the employment of the General Strike as a political weapon, we may take it as certain that that Act would never have entered the Statute Book. If the Labour Party persists in its objection to that definition of an illegal strike, its object will be manifest to all men. By the second section of the Bill members of unions who refuse to take part in an illegal strike are protected from victimisation. In the third section we find what is virtually a definition of peaceful picketting. The provisions of the section do not seek to prevent the employment of pickets. What they do is to declare that those pickets must not "intimidate." That is to say, cause in the mind of a person a reasonable apprehension of injury to him or to any member of his family or of violence or damage to any person or property, and the expression "injury" includes injury other than physical or material injury, and accordingly the expression "apprehension of injury" includes an apprehension of boycott, or loss of any kind, or of exposure to hatred, ridicule or contempt." Here, once more, opposition by the Labour Party must imply that it still desires to see those methods of intimidation, which are generally execrated by the public, employed for the purpose of gaining industrial or political objects. In other words, it would wrench from the individual his liberty of thought and action. The object of the next section is to protect those who do not wish to subscribe to the political funds of a union. Again, to oppose it is to interfere with the liberty of the individual. These are the essential clauses of the Bill, the clauses which reveal the principles which underlie its provisions. It is difficult, we repeat, to conceive how anyone who is honestly devoted to those principles of Government which should guide every administration—the welfare of the community and the liberty of the individual—can oppose them. The actual terminology may demand modification, there may here and there be some ambiguity, but beneath any such superficial blemishes there lies this intention, an intention to which all who are honest of purpose must subscribe.

All Acts of Parliament which declare certain acts of large bodies of persons to be illegal are subject to a common weakness. The criminal law is supported by the fact that the offender can be punished; the civil law by the fact that damages can be recovered for torts suffered. Now the ordinary criminal law is generally operative against single individuals or small groups. It is therefore possible to levy fines or to imprison. But when the offenders number many thousands, it is impracticable to put the law in motion against more than a small percentage, and it is obviously impossible to punish more than a small portion of the whole. As long, therefore, as the fear of punishment is the only deterrent, it is fruitless to expect such Acts to be really effective. Hence, we have little belief that the pains and penalties prescribed in the Bill would do much to restrain a mass of men from striking or intimidating if they desired to do so. One thing, however, the clauses which prescribe punishments would do. They would enable authority to arrest ring-leaders and to prevent the spread of sedition. But beyond that they would be valueless. Bearing this fact in mind, it will be seen that the only real hope of securing to the general community and to individual members of trades unions that liberty which the Bill seeks to provide must come from within the ranks of labour. We believe that to be not such a remote possibility as at first sight might appear. There are no means of knowing what proportion of the members of any union are opposed to political activities and non-industrial strikes, but we may say with safety that it is a very large number. Furthermore, the national characteristics of Britons to observe the law would increase that number. It follows, then,

that the mere declaration that such and such acts would be illegal might prove more effective than the prescription of punishments, which it would be difficult to inflict. We must, then, look to the rank and file of trade unionism and not less of non-union labour to make the measure effective, and we believe they will do so when they are convinced that its sole object is to prevent injustice and remove oppression.

Theoretical and Practical Lubrication.

The two recent joint meetings of the Institution of Mechanical Engineers and the Chemical Engineering Group have, if they have fulfilled no other purpose, served at least to define in clear-cut, almost startling, terms the issue between the theory and practice of lubrication. That the issue required defining, that indeed any issue at all existed between the two branches, may evoke reasonable surprise among many casual students of the subject. The history of lubrication during the past forty years appears to present at many points an unusual degree of agreement and co-operation between theory and practice. Towers' experiments were of a purely practical engineering nature; but scarcely had they been completed when Reynolds deduced from them with hardly an assumption which they did not justify, his classical theory of hydrodynamical lubrication, which to this day retains its prestige undiminished. In the whole field of applied science it is difficult to find a more complete *rapprochement* between practice and theory than that exemplified in the work of these two investigators. If it is equalled or excelled, it is only by the high mathematical studies of the same subject made by Michel and the important, very practical invention which came of them. Yet despite these, and other remarkable instances of reconciliation between the theoretical and practical aspects of lubrication, it is true that in many really fundamental respects the theorists are in total disagreement, not only with practice, but among themselves, while, on the practical side, opinion can be said to be unanimous only in the doubts and distrust expressed regarding the work of the scientists.

Were we to confine our attention solely to Dr. Ormandy's able and most interesting paper on the scientific aspects of lubrication, we might justifiably conclude that many of the perplexing, obviously fundamental phenomena of the subject had been, or were within an ace of being, resolved. Intense, prolonged, widespread research, carried out with apparatus of great refinement, under conditions of extreme control, has recently yielded results, deserving to rank as discoveries, which seem to require only co-relating on some proper basis to transform them into enlightening fundamental laws. For the time being, the basis of co-relation appears to be either elusive or intractable, but the impression prevails with us that, despite the disputes of the scientists as to the detailed interpretation of their individual observations, the stage has now been set for the entrance of another Reynolds, another Newton, to simplify and generalise. That impression remains, even although we have to recognise that in the advancement of their views and theories, the scientists seem to demand a tax on our credulity regarding the fundamental constitution of matter. It appears to be demanded of us that we shall abandon the simple conception of the molecule with which we have been brought up, and with which other scientists have explained other properties of matter. In place of a group of hard inelastic spheres, we are to imagine the molecule of oil as consisting of a stick or chain, with branches at one end, like the roots of a tree trunk, and are to bring the movement of these branches, or polar heads, within our conception of the mechanism of the molecule. The scientific lubricationist need not, however, fear the criticism of the casual student on this or any other similar point, if only he succeeds in resolving his own difficulties and in persuading the practical man that he has at last evolved a satisfactory and consistent understanding of the fundamental action of lubricants. We anticipate, however, that his gravest difficulty in reaching that goal will be to induce the practical engineer to believe that what he calls a lubricant has any real relationship to the lubricants used in practice, and that the conditions of lubrication which his theory presupposes to exist can by any stretch of the possibilities open to us be duplicated even approximately in every-day use. It is in this respect that we see defined the cleft between the theory and practice of lubrication. The mathematical elastician, with his idealised elastic bodies, has for a long time been wholly out of touch with practical materials, and has elaborated theories which are inapplicable to and even contradicted by the behaviour of practical materials. The scientific lubricationist with his critically clean surfaces, his chemically pure fluids and metals, and his rigorously controlled atmosphere, is in distinct danger of following his elastic brother into an abstract field possessing no interest and no value to practice. That would be a development to be greatly regretted. The impartial control and assistance of the scientist are essential if we are to avoid the confusion and conflict of opinion which Messrs. Marshall and Barton's paper shows as existing in the practice of judging and using lubricants. That paper seems to us to be a direct invitation to the scientists to return from abstract experimentation and speculative theory to the solid ground of practical research. It challenges the scientists to prove that they are correct in their conception of a property in oils which they call "oiliness," to prove that that property can be measured and to prove, if it exist and can be measured, that it has any influence on the running of lubricated machinery. It challenges them also to defend the carbonisation, oxidation, viscosity and other tests now in wide use as practical means of judging the lubricating value of oils, or to show, as the authors have sought to do, that these tests are in nearly every respect wholly deceptive or widely misleading.

It is the duty of the engineer, as Dr. Hele Shaw expressed it at the first of the joint meetings, to move things about and to keep them moving. Lubrication lies at the root of his ability to perform this duty with any pretence to efficiency. It is therefore logical to argue that lubrication makes engineering possible. However we may regard it, it is impossible to deny the importance of lubrication and very nearly impossible to exaggerate it. It is therefore surely to be deplored that at this late date many engineers are compelled to admit that the only guide to the relative values of different lubricants is actual trial in the engine or machine under service conditions. The theory of lubrication is a borderland subject of great fascination to the scientifically minded. The practice of lubrication is a matter of pounds and pence, frequently of life and death. The issue between the two is, as we have said, apparent and almost alarming. We readily accord to the work of Hardy, Langmuir and others on boundary lubrication, the surface energy of solids, the influence of contaminants and so forth, the attention and interest which the merits of their beautiful methods and results demand. It is impossible, however, not to regret that their researches are leading them ever farther and farther away from the materials and conditions of practice. Optical surfaces of pure metals cleansed at great pains of the last suspicion of contamination, and lubricated with fluids of British Pharmacopœia, or higher, purity, cannot be expected, when tested in air free from all mechanical and chemical impurities and carefully regulated in temperature, to yield principles or data applicable without violent adjustment or complete reversal to the relatively gross conditions of practice. The elimination of subsidiary variables is a sound principle of experimental research, but on the scientific side of lubrication the process, we suggest, has already been carried far enough. On the practical side we are still very distant indeed from knowing even which of the many variables are "subsidiary" and which of them are vital.

Literature.

Edison: The Man and His Work. By George S. Bryan. London: Alfred A. Knopf. 1926. Price 18s.

To relatively few men is accorded the honour of reading their own biographies. Indeed, in a more reserved age, it was deemed almost impertinent to discuss a man's life and works whilst he was still in the world. That reserve went in America long since, and is going in this country. There is something to be said on both sides. It is obviously impossible to weigh any man completely before Death has rounded off his career. Delicacy compels the biographer to leave some things unsaid and some conclusions undrawn, either because the praise would be fulsome to a living man or because criticism would be an impertinence. Yet there are some men who occupy such a large place in the affairs of the world that the public clamours to know all that may be known about them whilst they are still here.

Of such men is Alva Edison, an inventor, a scientist if you will, who is almost as popular in his native land as a film star, and is known by his works in all parts of the globe. This desire to know something of his life is very comprehensible in his case, for in the first place most of his inventions are of the kind that appeals directly to the populace—the phonograph and the kinematograph, for example—and in the second because his method has always been of a very human kind. Are we not gratified when we see a great man adding up his accounts on his fingers just as we do ourselves? That is Edison's way of inventing. He never seems to have gone about it on any scientific hypothesis. He just kept on trying and trying and trying until he got what he wanted. When he required a filament for his electric lamp, he did not reason out what the qualities needed were, and reach a conclusion with the certainty of a Sherlock Holmes. No. He set down to try *everything*, and sent men scouring the globe for fibres that might suit his purpose. His method is fundamentally that of trial and error, and no man with a less capacity for work and a physical constitution that could labour incessantly for twenty hours out of the twenty-four, and we must add no man with less ability for drawing around him helpers as zealous as himself, could achieve what he has done by the system he employs. His motto throughout his active career seems to have been "Try it." It is to be supposed that he made some selection, but in a general way if there was any chance, however remote, of success, and often in defiance of what others thought, he tried it. The number of tests he must have made individually or through his staff is incalculable.

As we say, this is a "human" method. The man-in-the-street can understand it. There is nothing recondite about it. Scientifically, it is Gothic; but in the hands of such a man as Edison it takes on greatness from the astounding courage and continuity with which it was pursued. Failure did not daunt him. He was always sure success was just in front. It only needed one more try. He might desert something for a time—the phonograph, for instance—but he returned to it. Went on trying and trying till he succeeded.

It is unnecessary to recall his principal inventions and adventures. They are familiar to all. The telephone, the phonograph, the kinematograph, the electric light, the storage cell are now household properties. With all of them Mr. Bryan deals in an easily readable way and always keeping the man to the fore. It may be that no "scientific" biography of Edison will ever be written, or none more complete than Dyer and Martin's. It may be that he will always stand out as a popular hero—a very different type of man from Newton or Kelvin or Dewar or Rayleigh, whom only scientists could fully understand. There are artists and poets who can only be appreciated by other artists and poets. There are scientists and inventors of the same order. But Edison is different. He can be understood by everyone. He is the popular inventor and discoverer *par excellence*. The popular type of biography seems therefore to be really appropriate to him, and Mr. Bryan's book, only one of several biographies of Edison, follows possibly the best course. It is certainly a volume which anyone may read with pleasure and with profit, too, if he be one of those who take encouragement from the study of the works and lives of men who have served the world well.

BOOKS RECEIVED.

Directory of Paper Makers, 1927. London: Marchent, Singer and Co., 47, St. Mary Axe, E.C. 3. Price 5s. net.

L'Organisation Scientifique du Travail. By G. Bricard. Paris: Armand Colin, 103, Boulevard Saint-Michel. Price 10·25 fr. net.

Successful Asphalt Paving. By P. J. M. Larranaga. London: R. Clay and Sons, Ltd., Blackfriars House, New Bridge-street, E.C. 4.

The Colliery Year Book and Coal Trades Directory, 1927. London: Louis Cassier Company, Ltd., 34, Bedford-street, W.C. 2. Price £1 1s. net.

Water Power Practice. By F. Johnstone-Taylor. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 21s. net.

Proceedings of the Rugby Engineering Society. Volume XX. Rugby: The Rugby Engineering Society, 10, Elbrow-street. Price 10s. 6d. net.

The Natural History of a Savant. By Professor C. Richet, translated by Sir Oliver Lodge. London: J. M. Dent and Sons, 10, Bedford-street, W.C. 2. Price 5s. net.

Proceedings of the Twenty-ninth Annual Meeting of the American Society for Testing Materials. Volume 26. Parts I. and II. Philadelphia: The American Society for Testing Materials, 1315, Spruce-street. Price $6·00 net.

Low Temperature Carbonisation: Fuel Research Technical Paper, No. 17. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 6d. net.

An Investigation of the Caking Power of Coal: Fuel Research Paper, No. 8. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. net.

New South Wales, Thirty-eighth Report of the Metropolitan Water, Sewerage and Drainage Board for the Year ended June 30th, 1926. Sydney: Alfred James Kent. 1927. Price 7s.

Wasserdurchlassigkeit von Beton in Abhängigkeit von seinem Aufbau und vom Druckgelfälle. By Dr.-Ing. G. Merkle. Berlin: Julius Springer, Linkstrasse 23, W. 9. Price 5·10 mk.

Handbibliothek für Bauingenieure. Part II.: *Eisenbahnwesen und Städtebau.* Vol. IV.: *Oberbau und Gleisverbindungen.* By Dr.-Ing. Adolf Bloss. Berlin: Julius Springer. Linkstrasse, W. 9. Price 13·50 Marks.

Institution of Naval Architects.

No. I.

THE annual general meeting of the Institution of Naval Architects was opened in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, London, on Wednesday, April 6th, under the presidency of his Grace the Duke of Northumberland, with the reading of the annual report of the Council.

ANNUAL REPORT.

The Council, in presenting their annual report, have again to refer to the severe depression in the shipbuilding and engineering industries during the past year, one result of which is reflected in the smaller number of candidates presenting themselves for admission to the Institution. The disastrous and prolonged industrial dispute of 1926 naturally had the effect of putting back still further the resumption of shipbuilding activity.

National Certificates in Naval Architecture.—Acting in conjunction with the Board of Education and the Worshipful Company of Shipwrights, the Council have set up committees for dealing with the award of national certificates in naval architecture in England (including Wales) and Scotland respectively, and the technical schools have been invited to send in their applications for enrolment under the scheme.

William Froude National Tank.—The Council learned with regret the resignation of Sir William Smith, C.B., from the post of Chairman of the Advisory Tank Committee, which he had occupied since 1919, and they desire to record their high appreciation of his invaluable services on that Committee since its inception in 1909.

The Board of the National Physical Laboratory have appointed Sir Eustace d'Eyncourt to be Chairman of the Committee in succession to Sir William Smith.

Experiments carried on at the Tank have formed the subject of several papers contributed to the "Transactions" during the past year, and the value to the shipbuilding industry of the Tank research work fully justifies the claim for additional financial support to the Research Fund from all who are interested in shipping and shipbuilding.

Secretary.—At the conclusion of twenty-five years' service as Secretary of the Institution, Mr. R. W. Dana was entertained at a complimentary dinner, given on July 14th last, by the Council, when the presentation of a silver ship was made by the Chairman—the Marquis of Bristol, Past-President—on behalf of the Council, as a mark of appreciation of the Secretary's services.

British Marine Engine Design and Construction Committee.—This Committee, constituted in 1917—Chairman, Mr. A. E. Seaton—has now been dissolved, as its work was completed when the reports published in 1921–22 were issued. The balance of funds in hand is being, with the consent of the subscribers, transferred to the Research Fund of the William Froude Tank.

The annual statement of receipts and payments appended to the report shows that the financial position of the Institution continues to be satisfactory.

The report was adopted.

The election of President, Vice-presidents and Treasurer, nominated by the Council, resulted as follows:—President: His Grace the Duke of Northumberland. Vice-presidents: Engineer Vice-Admiral Sir Henry Oram, the Hon. Sir Charles A. Parsons, Sir Alexander Gracie, Mr. J. Foster King, Sir Thomas Bell, Engineer Vice-Admiral Sir George G. Goodwin, Mr. Andrew Laing, Sir Eustace T. D'Eyncourt, Mr. W. H. Whiting, Mr. A. E. Seaton, Sir Westcott G. Abell, Mr. W. J. Luke, Lord Weir, Sir W. J. Berry, Mr. James Brown, and Mr. Summers Hunter. Treasurer: Sir Charles Ellis.

The following is the result of the ballot for Vice-president, members of Council and associate members of Council for 1927:—Vice-president: Engineer Vice-Admiral Sir Robert B. Dixon. Members of Council: Mr. John Austin, Mr. W. J. Willett Bruce, Mr. A. E. Doxford, Mr. P. D. Ewing, Engineer-Commander C. J. Hawkes, R.N. (ret.), Professor P. A. Hillhouse, Mr. C. F. Monday, Sir Archibald Ross, and Mr. F. J. Stephen. Associate members of Council: Rear-Admiral Sir Douglas Brownrigg, Mr. W. L. Hichens, the Right Hon. Walter Runciman.

The President, presenting, on behalf of the Institution, the Diploma of Honorary Membership to Admiral Sir Reginald Custance, said the Institution had felt that this, the greatest honour which it was in its power to bestow, could not be bestowed upon one more worthy. In making the presentation, all the members of the Institution would wish to pay their tribute to the great services which Sir Reginald had rendered to his country in the course of a very long and distinguished career in his Majesty's Navy, a career which had extended over a period of more than fifty years. He believed Sir Reginald first saw service in the Far East in 1862. The members would wish to pay their tribute, in the second place, to his valuable work in connection with his writings on naval science. Many of these writings had been contributed to the Institution, and had been of the greatest value, and on one occasion Sir Reginald had won the Gold Medal of the Institution. He had also written many books on naval strategy, one of them, which appeared about three years ago, being of very great value, because it had brought that somewhat technical and difficult subject within the comprehension of even the most ignorant laymen. Such a book as that was of very great value at the present time, when somewhat crude and amateur ideas on naval strategy were being propounded in exalted quarters.

The diploma was then presented, amid applause.

Admiral Sir Reginald Custance, after expressing thanks for the honour done him and for the kind manner in which the President had referred to him, recalled the names of those who had taken a leading part in the affairs of the Institution some fifty years ago. He mentioned Sir Edward Reed, Sir Nathaniel Barnaby and Sir William White, who were in the front rank at that difficult time, when the ironclads were first introduced.

The President then presented the Institution's Gold Medal to Mr. Robert Sulzer, and took the opportunity to congratulate him, on behalf of the Institution, upon the excellent essay he had contributed and to express appreciation of the splendid work he was doing in connection with the improvement and development of the Diesel engine.

Mr. Robert Sulzer, briefly returning thanks, said he regarded the award of the Medal not so much an appreciation of his personal merit as an appreciation of the work of his firm and the engineers associated with it in the development of the marine Diesel engine.

PRESIDENTIAL ADDRESS.

The President, in his presidential address, said it was both a pleasure and a privilege for him to preside once again over the meeting of the Institution. His normal term of office as President should have expired last year, but owing to the prospect of another summer meeting this time at Cambridge, the Council had once more done him the honour of inviting him to continue in office for another year, and he had gladly consented. The summer meeting at Cambridge promised to be one of great interest, as it would be the first time in the history of the Institution that the members had visited officially that ancient seat of learning. It was true that there were no shipbuilding or marine engineering works to be visited, but there was a great School of Engineering, which, under the successive guidance of Sir Alfred Ewing, the late Professor Bertram Hopkinson, and now Professor C. E. Inglis—all of whom were or had been connected with the Institution—had added a large number of well-trained engineers—amongst them many members of the Institution—to the ranks of the profession, and the school was one of the best training centres in the country. Moreover, Sir Charles Parsons, a distinguished Vice-president of the Institution, was a Cambridge man. It was there that his earliest experiments on the turbine engine were carried out, and Cambridge might thus be described as the birthplace of the turbine engine as we knew it to-day. The promise of a warm reception from the Vice-Chancellor and University authorities made the members of the Institution look forward to a visit which, he was sure, would be attended with both profit and pleasure.

In a reference to the summer meeting of the Institution last year in Belgium, the President said that the highest expectations were more than fulfilled. From his Majesty the King of the Belgians downwards, the Belgian hosts had shown themselves to be past-masters in the art of hospitality, and he was sure that those who had taken part in the visit would remember it with gratitude and pleasure.

The year 1926, continued the President, had been for the shipbuilding world a continuation of the long and severe period of depression under which our great industries had been suffering since the short-lived activity which had succeeded the war period, and the statistics of shipbuilding and marine engineering for the past year made rather gloomy reading. He would not enlarge on the dark side of the picture; suffice it to say, that the tonnage of merchant ships under construction in Great Britain and Ireland at the close of 1926 was the lowest figure recorded for seventeen years past, and showed a reduction of no less than 3,000,000 tons, as compared with the record figures of March, 1921, or of over 1,000,000 tons as compared with the average tonnage building during the twelve months immediately preceding the war. He was glad to say, however, that a more hopeful outlook seemed to have dawned on our industrial horizon. Much of the useless shipping which cumbered the harbours of the world after the conclusion of the war had now been absorbed or scrapped, and shipping companies, after waiting for the cost of production to fall to within economic limits, had now begun to place orders which gave shipbuilders fresh hopes of that revival for which they had been waiting so long. The President of the Board of Trade had recently made some optimistic forecasts of British trade prospects conditional upon our having taken to heart the lessons of last year's strike and industrial disputes. There was no doubt that the British worker was still capable of turning out as good, if not better, work than any of his competitors, but we in this country were handicapped in output by the longer hours worked on the Continent and to a certain extent by the more modern plant which many shipyards abroad had laid down or plant which had been renovated within recent years, and by trade union restrictions. The reduction in warship building, synchronising as it had with a decline in demand for new mercantile tonnage, had enormously increased our difficulties. One result of this reduction had been to cause the discharge of a large number of dockyard operatives—not only skilled men, but also apprentices. The effect of that step was two-fold. The men, being unable to find remunerative work, had swollen the ranks of the unemployed, and they became discontented and discouraged. If left too long in such a state they lost their skill and energy, while those who had the courage to face new conditions went abroad and were lost from our roll of effectives. But the discharge of apprentices had an even more disastrous and far-reaching effect, for it diverted from the shipbuilding trades and profession a number of skilled and partly trained young men who drifted into other occupations and into unemployment at an age when they should be completing their training and getting fitted to fill vacancies which age would create in the older ranks. They would never again have the opportunity of getting their training during the receptive years when the best among them might aspire eventually to fill high places in the engineering world. The falling off in the number of student members of the Institution and of applicants for scholarships and certificates and the reluctance of parents to see their sons embark on a shipyard career, were unmistakeable signs that the evil of this policy was already bearing fruit. Shipbuilding was one of Britain's key industries, and should at all costs be prevented from losing its future skilled operatives. These could not be improvised, nor could they be efficient without proper training. The President urged upon the thinking public the real need to arrest this source of decay before it went too far. To arouse strong public opinion was the first step towards reform, and the time had come for active intervention and redress.

A matter which had recently come before the Council of the Institution was that of the proposed Bill for the registration of engineers. That Bill would be a far-reaching measure affecting members of professional institutions, such as the Institution of Naval Architects, comprising all those engaged in engineering in the widest sense of the term. The proposal had met with unanimous opposition on the part of all the leading societies, and he understood that the Bill had no possible chance of becoming law. But one indirect result of the steps taken to oppose it was to show how unorganised the engineering profession was as regarded representation in the Legislature. The number of Members of the House of Commons who were or had been trained as naval architects or marine engineers was absurdly small in comparison with the importance of those industries. It was to be hoped that engineering, in its broadest sense, might in the future be more strongly represented and better organised to advance engineering interests.

We were all painfully aware that we were passing through critical times. Industrial prosperity could be restored only by whole-hearted co-operation between all sections of the community and by economy on the part of the Government. Taxation and rates were throttling our industries; expenditure must be reduced if prosperity was to be restored, and one of the most serious factors in the situation was the powerlessness, or apparent powerlessness, of the House of Commons to provide any effective check on the squandering of public money.

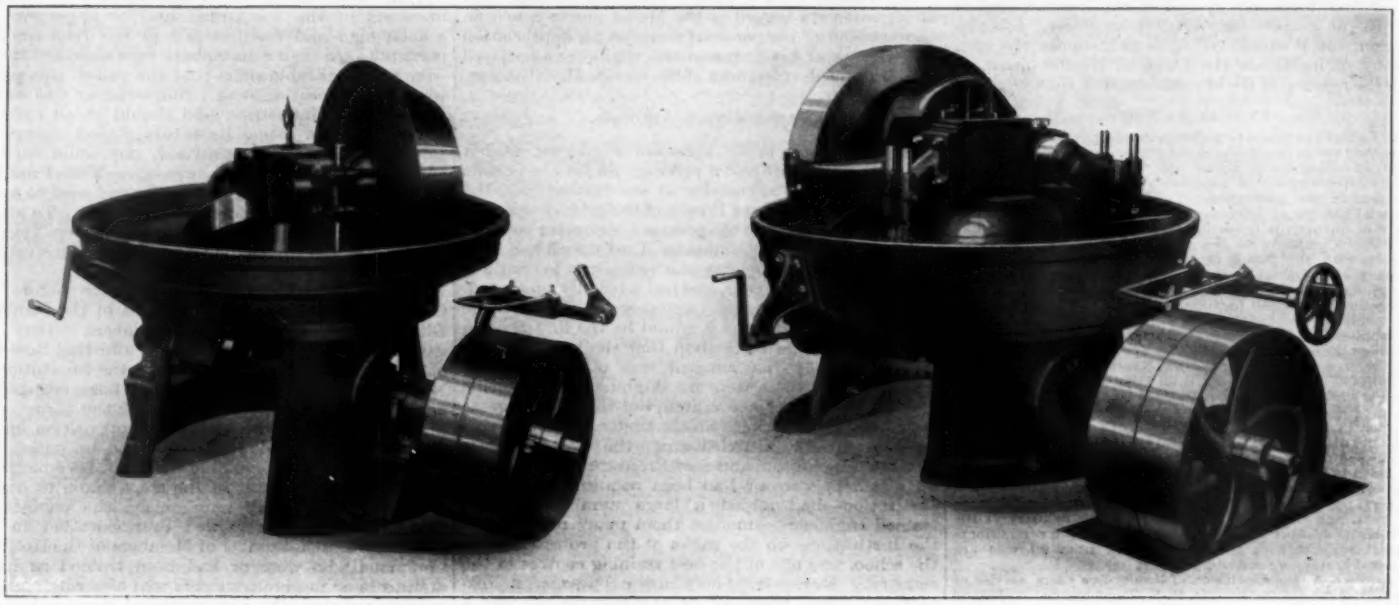
We still had great resources in primary materials, in man power and brain power, and in the still untapped resources of a vast Empire, but unless public opinion could be roused to our present dangers, the hopes of trade revival which had been so ardently cherished were not likely to materialise.

At the conclusion of the presidential address a paper by Sir Charles Parsons, entitled "Some Investigations into the Cause of Erosion of the Tubes of Surface Condensers," was read. It is reprinted elsewhere in this issue. An interesting cinematograph film was also displayed, illustrating the experiments in a convincing and interesting manner. In presenting his paper Sir Charles said that the experiments described in it were possibly incomplete, but that they would nevertheless serve to throw light on the causes of erosion in condenser tubes. Later experiments had indicated that the rate of moving the water box was probably too slow to obtain the maximum erosive effect. In new experiments, of which he hoped to give an account later, the effect of applying pressure and temperature to the tubes was to be studied. It was possible that by employing such means erosive and corrosive action might be reproduced at any part of the tube.

Engineer Vice-Admiral Sir Robert B. Dixon said that although the paper undoubtedly proved that one cause of condenser tube failure was erosion due to water hammer, he was not convinced that it was the main cause or even the major cause. It still appeared to him that ordinary corrosion was the main difficulty to be dealt with. However, assuming that erosion was one of the causes, then the remedies which Sir Charles Parsons proposed appeared to him to be quite efficient so far as they went, but there were serious disadvantages. In the first place, the grid, which it was suggested should be fitted at the inlet end of the condenser tubes, would no doubt remedy the vortex action, but it had two serious disadvantages; it added materially to the weight of the condenser, and it affected the time in which a defective tube could be found and plugged. At the present time a defective tube could be found out and plugged in a period varying from half-an-hour to 1½ hours, but if these grids were fitted that period would be lengthened to a very material extent. The second remedy suggested was by the reduction of the velocity through the tubes. That again had a grave defect from the naval point of view, because it added very materially to the weight of the condenser. Assuming, however, that the problem of erosion could be effectively dealt with, there was still the problem of corrosion. In the six months ending December, in all the ships in commission in the Fleet, there were something like 2,890,000 condenser tubes for main and auxiliary purposes, and during that period of six months only

PAINT-MIXING MILLS

TORRANCE AND SONS, BITTON, NEAR BRISTOL, ENGINEERS



FIGS. 1 AND 2—CONICAL AND PARALLEL EDGE-RUNNERS

eighty tubes were defective, which was the small percentage of ·0028. From that it might appear that the condenser tube difficulty had been overcome; that was not so. A condenser tube going out of service might lose a ship, and therefore it was essential to obtain some means of eliminating condenser tube troubles. The Corrosion Research Committee, he believed, had carried out some rather valuable work on the cause and remedies of corrosion, and it also suggested a reduction of velocity through the condenser tubes, but he was inclined to think that the remedy must lie in some other materials of construction. The tube makers were taking steps to try other alloys, particularly cupro-nickel alloys, with a view at all events to reducing the number of condenser tube failures. The Admiralty was also carrying out a number of tests on different materials for condenser tubes, so far with fairly satisfactory results, but it was too early yet to say whether the various alloys which were being tried were really better than what is known as Admiralty material for condenser tubes.

Mr. Sterry B. Freeman said that, although the paper stated why tubes eroded, he was not clear why tubes corroded. He regarded erosion as that condition in which the tube was bitten out and pock-marked and pitted, whilst corrosion he regarded as that state in which there was some de-zincification effect and a whole area would drop out. Could water hammer produce the de-zincification effect? He suggested that if water hammer of collapsing vortices would include the breaking up of air particles with microscopically small bubbles, it might assist the process, but he could not see that the hydro-dynamic effect could cause the corrosion. In certain cases of corrosion—of which he showed slides—the metal was removed under a nodule of scale. Would water hammer not remove the scale? Another slide showed what the speaker referred to as a delightful form of corrosion. The tubes shown were from a condenser twenty-four years old. The exterior was of brass untouched by age. The interior was apparently of copper. The brass had been dissolved and the copper re-deposited and this process had resulted in the production of a very thin tube, perfectly tight and highly efficient for its purpose of steam condensation. This tube was capable of being twisted, there were no holes in it, and it acted extremely well as a condenser tube; it did, in fact, what condenser tubes ought to do. In the big fleet with which he was concerned, a very close record was kept of condenser tube service, and he quoted one instance. The ss. Phemius left the builders in November, 1921. In eight months the 70 : 29 : 1 tubes failed almost *en bloc* through erosion or corrosion and were removed. Between July, 1922, and October, 1924, 1052 tubes had failed; 420 in the top and 632 in the bottom box. In February, 1925, the tubes were sprayed with bitumastic solution. At this time three tubes had failed in the upper and 45 in the lower box. In April, 1925, the chief engineer fitted a perforated mild steel plate, $\frac{3}{4}$in. thick, in the lower box at the inlet end, and no further spraying with bitumastic was done. The subsequent renewals have been:—June, 1925, 8; November, 1925, 8; April, 1926, 5; August, 1926, 4; March, 1927, nil. As in the sandy waters of the Suez Canal and the various rivers through which his vessels pass, the bitumastic usually lasts intact little more than a year, it seemed as though the grid was doing good work, and although one swallow did not make a summer, it rather seemed that this palliative confirmed the conclusions in the paper. The theory underlying the use of the grid was that the dissolved air in the water is thrown out by contact with the grid and escapes through the air holes provided, to pass overboard harmlessly. As far as he could see, corrosion was due to combined mechanical and chemical effect and the controlling factor is air. The difficulty was one of design in getting a parallel flow through the condenser in rather crowded engine-rooms.

Dr. G. Bengough drew attention to a paper written by Mr. May and himself and read before the Institute of Metals in 1924, in which work carried out for the Corrosion Committee of the Institute was described. In that paper conclusions were arrived at very similar to those given in the present paper, as to the influence of vortex action in setting up local corrosion in a condenser tube. The experiments were carried out on rather different lines from those of Sir Charles Parsons, the tubes being only 3ft. long and not 15ft. long, and although the conclusions were practically the same, a rather different explanation was given from that given by Sir Charles Parsons. He believed that he was correct in saying that, as regarded chemical and metallurgical people, they used the word "erosion" to denote the mechanical cutting away of the metal, and they used the word "corrosion" to mean oxidation of the metal. He did not know whether engineers used the words in the same way. From the paper it appeared that Sir Charles had referred to the action he had studied as being almost entirely due to the mechanical cutting away of the metal. In the experiments described in the paper by Mr. May and himself in 1924 they came to the conclusion that that was not the whole story, but that there was first a cutting away of the film of corrosion products on the metal by the effect of the vortex and then, having cut away the protecting film, the metal began to corrode. It was well known that the industrial efficiency of all metals depended entirely upon the coating or film of corrosion products. If that were cut away there would be violent corrosion under mildly corrosive conditions, and in the paper he had referred to the action of these vortices was explained along these lines. He did not think that such an action as de-zincification, which had been mentioned, had anything to do with the action studied by Sir Charles Parsons. The causes of de-zincification were well understood and methods for preventing it were well known. No engineer need lose a single tube owing to the action of de-zincification, and if anybody had any trouble from that cause the investigators of corrosion at the Institute of Metals would be able to provide sufficient information to enable the trouble entirely to be overcome. His view was that the action of these vortices was a joint action, partly mechanical and partly chemical. The erosive action started first, followed by the chemical action. Sir Charles Parsons would probably be interested in Patent No. 20,605 of December 11th, 1910, taken out by Mr. Kettle, the engineer-in-charge of the Dublin electricity works. This gentleman put into his condenser tube end a grid of very similar shape and dimensions to that proposed by Sir Charles Parsons, and the object in that case was to obtain a certain amount of electro-chemical protection for the tubes; but it was found in the end that the grid did nothing to prevent corrosion, and the reason was quite clear. In that case the trouble was not due to the vortices mentioned by Sir Charles Parsons, but to the fact that estuary water, which contained a considerable amount of sulphuretted hydrogen, was used, and a mixture of sea water and sulphuretted hydrogen was one of the worst possible things to have in conjunction with condenser tubes containing brass or copper. In the Dublin case the remedy was not effective, and that rather emphasised the point that, although there was quite a number of different causes of corrosion in condenser tubes, it was not likely that any one remedy would suit every case.

The remainder of the discussion on this paper will be given in our next week's issue.

The annual dinner of the Institution took place on Wednesday evening, April 6th, at the Connaught Rooms, the chair being taken by the President, the Duke of Northumberland. Over six hundred members and guests were present. The toast of "The Royal Navy" was given by the President and was acknowledged by Admiral Sir Richard F. Phillimore, who recalled the great services which were rendered during the war by the engineer officers of ships and the engine-room complements. Lieut.-Colonel C. M. Headlam, Parliamentary Secretary to the Admiralty, proposed the toast of "The Mercantile Marine," and Mr. A. C. F. Henderson, of the Cunard Steamship Company, made a fitting reply. The toast of "The Overseas Dominions" was proposed by Sir Archibald Ross, and Sir Joseph Cook, High Commissioner for Australia, responded. The Minister for the Netherlands gave the toast of "The President of the Institution of Naval Architects," replying to which the Duke of Northumberland made reference to the great services which had been rendered to the Institution by the Secretary, Mr. R. W. Dana, who had recently completed twenty-five years of service. The silver ship which was presented to Mr. Dana by the Council to mark this event was on view during the evening.

(To be continued.)

Paint-making Machinery.

No. I.

The construction of the machinery used in the manufacture of paint has undergone considerable changes within recent years, and has developed from a very rough sort of engineering into a highly specialised business, while the composition of the paint itself is rapidly undergoing important radical changes, so that the literature dealing with paint making of only a few years ago is little guide as to the present state of the industry. Although we have, within recent times, made some reference to individual machines used by paint makers, we have not, so far, given a connected account of the plant and processes employed, but it is hoped that the following notes may offer some insight into present practice, and incidentally emphasise the desirability for those paint manufacturers who are still employing old fashioned plant, of replacing it by really modern machinery. In this connection it is not proposed to go right back to the production of the raw materials—the pigment, oil, dryers, &c.—as such processes as the levigation of earthy pigments, the production of lead and zinc whites, and the expression of linseed oil are well established on standard lines. It is rather our purpose to start at that stage of manufacture where the various ingredients are combined together to form the ready-

mixed paint and to describe the machinery employed in the several operations.

In order to make this account as connected as possible, we propose first to describe a complete series of machines by one maker, in proper sequence, and then to give details of what may be described as parallel machines, by other makers, that perform similar functions.

Briefly stated, the process of paint making consists in roughly mixing the various ingredients together, batch by batch; grinding the resultant paste to insure that each particle of the pigment is completely enveloped by the vehicle; diluting the paste with more oil, to bring it to the proper consistency; and finally refining the paint, to remove impurities and give it a smooth texture.

Probably by far the largest proportion of paint is prepared from white paste, subsequently tinted, having white lead, zinc white, barytes, titanium, lithopone or some other materal as base; but in some cases the colour is added at the start, and then the colour and base are mixed together in the dry state. For such purposes the mill shown in Fig. 1, which is by Torrance and Sons, of Bitton, near Bristol, is one of the most modern forms. As will be seen it is an edge-runner mill, but instead of having a flat bottomed pan and a corresponding parallel roll, both parts are conical. The pan, which is fixed, tapers inwards to the common centre, and the roll tapers outwards, or the reverse to a pair of mitre wheels, which have to gear together. The result is that as the roll travels round the pan there is a considerable difference in relative speed of the surfaces in contact except in the mean position. The result is a grinding action which prevents the material from being consolidated into a bed, on the top of which the roll would run without affecting the interior portion. The material is instead thoroughly ground and stirred up by the roll, while the action is accelerated by a set of doctors that travel round the pan with the roll. The mechanical construction of the mill is so obvious as to need no explanation, but it should be pointed out that the surfaces of the pan and roll are turned up quite true and highly polished. It is really surprising how quickly a small proportion of colour will be intimately mixed with a charge of, say, white, so that the whole is of a uniform tint. These mills are made with pans of from 4ft. 6in. up to 7ft. in diameter for manufacturing purposes, while there is a little hand-operated set with a 13in. pan for experimental work.

The dry ingredients and the oil, &c., may be mixed together, to form a paste in several entirely distinct forms of machine, but there seems to be a general tendency towards the adoption of the edge runner type of mill for this purpose. In this case, however, the conical form of mill is not so much favoured, and such a mill as that shown in Fig. 2, which is also by Torrance, is more suitable.

As will be seen from the illustration, the machine comprises a fixed pan with a flat bottom and slightly flaring sides round the inside of which there trundles a parallel sided roll. In the case of large mills, with pans of about 8ft. in diameter, two rolls are sometimes used, as shown in Fig. 3—but in smaller sets it is generally considered that one roll is preferable. The use of two rolls naturally doubles the rate of action on the material, but against this there must be set the loss of accommodation in the pan, caused by the displacement of the rolls, and the increased power consumption. The rolls are generally of cast iron, but for some purposes, such as grinding distempers, granite rolls are sometimes used.

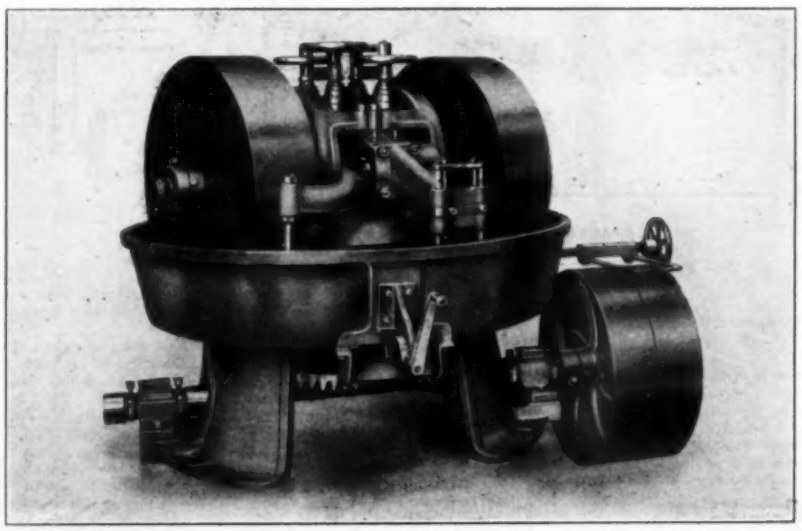


FIG. 3—POSITIVELY-GEARED DOUBLE EDGE-RUNNER MILL—TORRANCE

On reference to Fig. 2 it will be seen that a hollow casing extends upward in the centre and accommodates a bevel gear-driven vertical spindle. The casing is, of course, adopted to avoid the necessity for a stuffing-box where the spindle comes through the bottom of the pan. On the top of the spindle there is a massive casting to which the roll and doctor knives are fixed. The attachment for the roll takes the form of a drag link which keeps the axis of the roll radial to the centre of the pan, but allows the roll to rise and fall to accommodate inequalities in the thickness of the bed of material in the pan.

In view of the greasy nature of the materials handled by these machines it would not be practicable to rely on the friction of the roll to make it rotate as it goes round the pan—it might merely slide forward pushing a wave of paste in front of it—so the roll is positively driven in the following manner. On the inside face of the roll there is a toothed crown wheel, which meshes with a corresponding wheel on the central casing. The ratio of this gearing is the same as the relation of the diameter of the roll to its mean path round the pan, so that the roll is positively driven to keep in pace with its orbit round the centre, but there is sufficient freedom in the length of the gear teeth to allow for its rise and fall on the drag link.

The doctor knives are held by brackets fixed to the head casting, and each one is attached by two vertical spindles. The spindles have an excentric movement, and can be adjusted vertically, so that the position and angle of the doctors can be set very conveniently and accurately. Their edges are fitted very carefully, by hand scraping, to the contour of the pan, and when a batch has been discharged there is nothing left in the pan but the merest stain round the sides. This is obviously a great convenience when changing colours. The door through which the batch is discharged is in the bottom of the pan, and the handle for operating it can be seen in the illustrations. The slides and seating for the door are planed, as is also the door itself, so that the joint is hardly perceptible from the inside, and the roll has a perfectly smooth passage round the bottom of the pan.

The action of the mill is, it will be seen, a combination of rolling and grinding, as there must be some slip at the inside and outside edges. The material is thoroughly mixed up, and its density kept at the maximum, while little or no heat is generated—a matter of considerable importance when dealing with white lead, as heat is liable to discolour it. For some purposes, however, the pans are provided with jackets, so that they may be heated or cooled as desired.

The alternative system of primary mixing is the employment of a stirring machine, and when this principle is adopted, the arrangement is almost invariably horizontal, as is indicated in Fig. 4, which represents a Torrance mixer.

The mixer is really a very simple machine, and comprises a U-shaped trough, along the centre of which there runs a shaft that is driven by appropriate gearing. On the shaft there is keyed a series of two-armed paddles with blades set at such angles that they tend to work the batch of material over and over, and towards the centre of the trough. The paddles at the two extreme ends just rub against the end castings of the trough, so that no paste is left adhering there, and the centre paddle has a "square" blade for pushing the masticated charges through the outlet in the bottom. This form of mixer is not infrequently steam-jacketed, so that stiff pastes can be dealt with without undue expenditure of power, and is then usually provided with a cover to check the escape of vapour and heat.

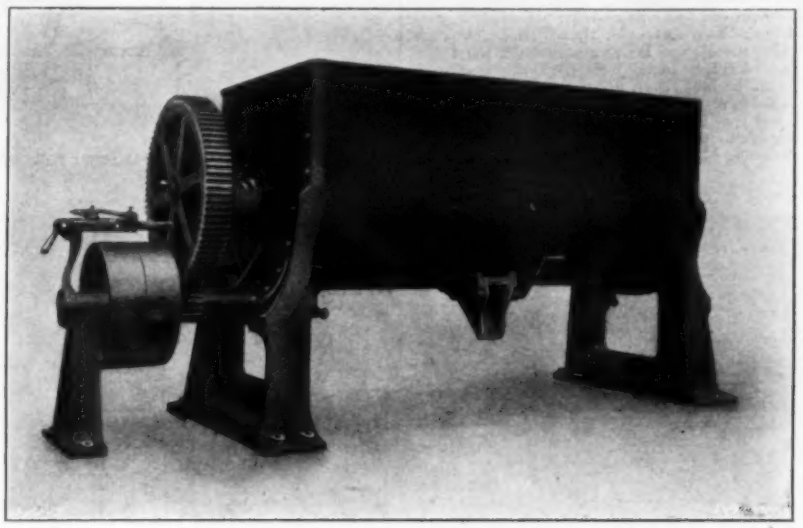


FIG. 4—STEAM JACKETED MIXER—TORRANCE

By comparison with the edge runner, the chief disadvantages of the horizontal mixer are the tendency of the charge to heat up on account of the friction of the moving paddles, and the increase in the bulk of the mixture on account of its aeration by the paddles. This form of mixer does, however, perform a very useful purpose in acting as an intermediary between an edge runner and the next process of grinding, which will be described later. In such cases the trough is divided into two, longitudinally, and the two parts are worked alternately. The partition should then be formed of two separate plates, with a small intermediate space, after the fashion of the bulkheads of an oil tank steamer, so that there is no fear of leakage from one half of the mixer to the other, while an adequate support is provided for the bearings of the inside ends of the two mixer shafts, as it is the invariable practice in such cases to divide the shaft at the centre of its length and provide a separate drive at either end.

There are some other forms of mixer, such as those very much like a dough kneader, in service in some factories, but those which we have just described are more commonly in vogue. The next step in the preparation of the paint—the milling of the paste—is perhaps one of the most serious considerations of the paint maker, and it will be dealt with in the next of these articles.

(To be continued.)

Obituary.

KONRAD ANDERSSON.

THE death of Mr. Konrad Andersson, the manager of the steam turbine department at Greenwood and Batley, Ltd., of Leeds, took place at his home, Tewit Tower, Harrogate, on Tuesday, March 29th. Mr. Andersson, who came to this country from Sweden in 1899, was well known in the engineering world, was a brilliant mathematician, and had for many years been engaged in experimental and research work. He had been associated for some time with Leeds University, and was an honorary member of the Senate of that body. During the war he devoted all his time to work for the Admiralty.

ACCORDING to Lieut.-Colonel Ashley, the number of motor vehicles of all kinds on the roads of Great Britain in 1926 was 1,730,000, and the probable increase during the present year may be estimated at 150,000.

Erosion of the Tubes of Surface Condensers.*

By Sir CHARLES A. PARSONS, K.C.B., F.R.S., Vice-president.

THE problem of the failure of the tubes of surface condensers is so well known that it seems only necessary here to allude to a few of the salient facts bearing upon the question. Whilst no adequate explanation has as yet been assigned for such failure, many attempts have been made to overcome it. On the theory that it is caused by electrolytic corrosion, counter-electromotive force has been applied to neutralise the action; on the theory that it arises from chemical action, such means as coating the inside of the tubes with a bituminous paint or with a protective scale of oxide have been tried. None of those measures have proved to be more than palliative in their effects, and sometimes not even that. In a few cases more expensive metals are being adopted for the tubes, such as cupro-nickel or monel metal. For many years bell-shaped mouths have been fitted to the inlet ends of condenser tubes to produce a smooth stream-line flow into the tubes,† and this is claimed to prevent the formation of a *vena contracta* by the sharp square entrance to the tube and the liberation of oxygen and other occluded gases from the water which cause corrosive action at the tube entrance.‡

In most cases of failure it has been observed that certain of the tubes are eroded, corroded, pitted, and eventually holed, but always, or nearly always, from the water side, that is to say, from the inside surface. The action is usually confined to tubes in certain regions of the condenser tube plate, and if such tubes are replaced from the common batch they have usually failed just as quickly, whilst in other positions in the tube plate the original tubes have remained immune, so that there appear to be distinctive areas in which the conditions favour corrosion or erosion. Further, it appears that the action is greatest at the entry ends of the tubes, frequently extending only a few feet from the mouth. These facts seem to suggest that the cause may be hydro-dynamical rather than electrical or chemical, and in the light of the experiments described in this paper they seem to indicate that these areas of erosion or corrosion are associated with regions of turbulent motion of the water in the water box.

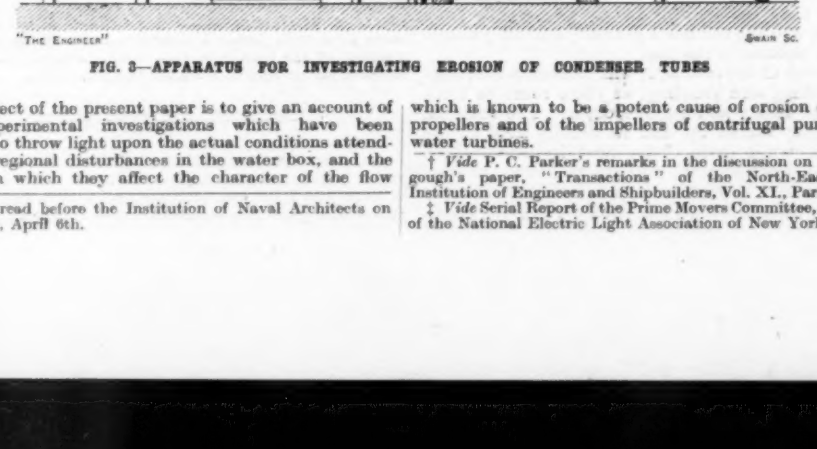


FIG. 2—ARRANGEMENT OF WATER BOX

The object of the present paper is to give an account of some experimental investigations which have been designed to throw light upon the actual conditions attending such regional disturbances in the water box, and the manner in which they affect the character of the flow which is known to be a potent cause of erosion of screw propellers and of the impellers of centrifugal pumps and water turbines.

* Paper read before the Institution of Naval Architects on Wednesday, April 6th.

† *Vide* P. C. Parker's remarks in the discussion on Dr. Bengough's paper, "Transactions" of the North-East Coast Institution of Engineers and Shipbuilders, Vol. XL., Part 2, 1923.

‡ *Vide* Serial Report of the Prime Movers Committee, 1926–27, of the National Electric Light Association of New York, U.S.A.

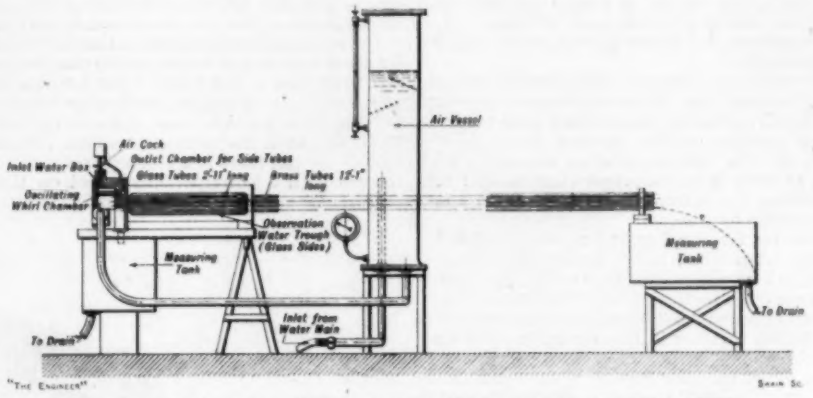


FIG. 1—APPARATUS FOR DEMONSTRATING VORTEX MOTION AT TUBE ENTRY

A paper was read before the Institution in 1919 by the present author and Mr. Stanley S. Cook on "The Cause of Erosion of Propellers." The paper recounted the investigations carried out by the Propeller Erosion or Corrosion Committee of the Board of Invention and Research. In that paper experiments with a water hammer cone were described, in which it was shown that by concentrated collapse of a vacuous cavity in water under atmospheric pressure small holes could be punched through brass disc, demonstrating the production by this means of shock pressures as high as 150 tons per square inch. The conclusions of the Committee were that the powerful and erratic erosion experienced with propellers was due to vacuous cavities in the water arising from eddies caused by struts or bossing, or by excessive slip of the propeller itself, which cavities collapsing on the surface of the propeller blade caused repeated blows and erosion of the metal.

The first of the present experiments was designed so that the behaviour of the water in the water box and also in the tubes could be observed and, if desired, photographed.

The apparatus shown in Fig. 1 was constructed. It consists of a small wooden water box, the front being of plate glass, with a brass tube plate for ten tubes. To facilitate observation the first 3ft. of the four tubes of the central vertical row were made of glass also, the tubes of the side rows were omitted, and instead retarding plugs were fitted giving the same discharge as a 15ft. length of condenser tube. The discharge from these side holes was led into a separate chamber immediately behind the tube plate. The four central glass tubes passed through the back of this chamber and were joined at their ends by clamped rubber tube couplings to brass tubes 12ft. long, making a total tube length of 15ft. They were also surrounded by a rectangular water tank with plate glass sides so that—the refractive index of glass and water being nearly the same—the water inside the tube could be seen without appreciable refraction. The discharge from the long tubes was taken into a measuring tank with a glass front, so that the trajectory of the water issuing from the tubes could be observed.

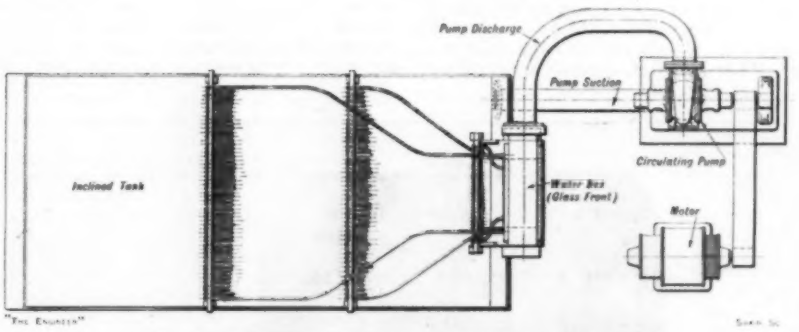


FIG. 4—ARRANGEMENT OF MODEL WATER BOX AND TUBES

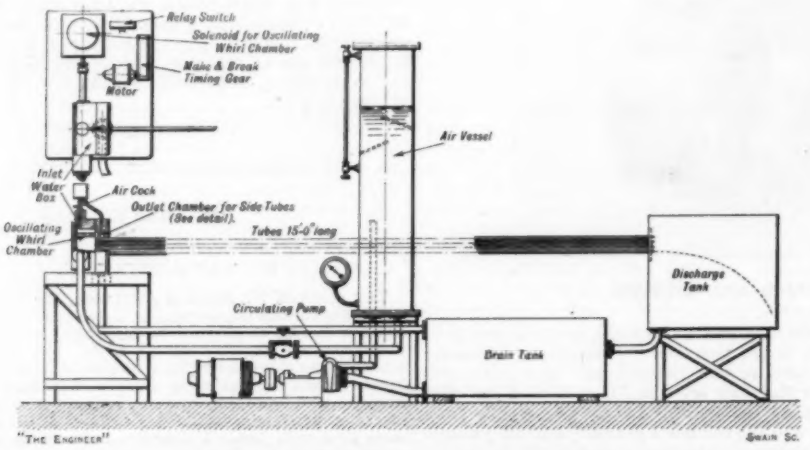


FIG. 3—APPARATUS FOR INVESTIGATING EROSION OF CONDENSER TUBES

Closely fitting between the front plate glass of the water box and the tube plate, an inner and movable water box of circular shape was fitted, into which the water was led tangentially through a socket fitting. This inner water box was moved by a lever passed through a stuffing-box; guides and stops as shown in Fig. 2 controlled its motion, so that it could be moved up and down across the face of the tube plate. An air vessel on the water supply to the box maintained a steady pressure of about 10 lb. per square inch. With water entering the water box at a speed of 8ft. per second, which was also the speed of the water through the tubes, a vortex filament was observable near the centre of the circular inner box, extending across from the glass plate to the tube plate. By moving the box this vortex could be brought over the mouths of tubes Nos. 2 and 3 of the four central tubes. The tubes No. 1 and No. 4, top and bottom, being only presented to the outer zones of the vortex filament.

The following results were observed when a vortex filament was in this way brought over the mouth of a tube, through which up to that moment the water had been flowing with a speed of 8ft. per second.

(1) The vortex was drawn into the mouth of the tube.

(2) The flow in that tube was partially arrested, the discharge being reduced in a fraction of a second to about one-fifth of its previous quantity.

(3) The vacuum at the core of the vortex brought over the tube mouth was momentarily intensified by the arrest of momentum of the water already in the tube.

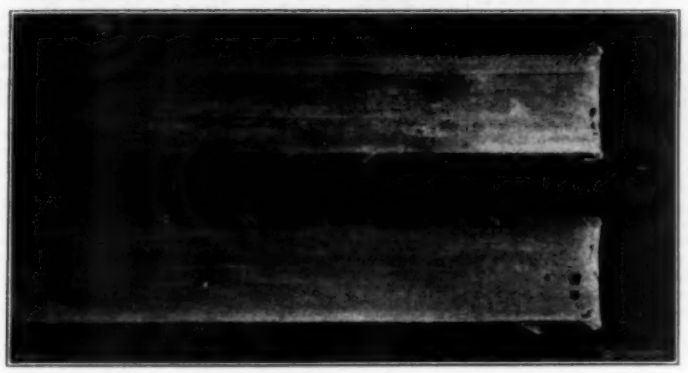
(4) A vacuous thread extended momentarily into the tube for about half the length of the glass portion, and then collapsed irregularly at various points.

ERODED CONDENSER TUBES

TUBE NO. 1

TUBE NO. 4

FIG. 5—TUBES NOS. 1 AND 4 SUBMITTED TO THE OUTER ZONES OF VORTEX



TUBE NO. 2

TUBE NO. 3

FIG. 6—TUBES NOS. 2 AND 3 SUBMITTED TO THE CENTRAL PART OF VORTEX

(5) Silvery looking fringes appeared momentarily on the entry edges of all the four tubes whether under or near the vortex.

(6) It was observed that at the instant when the vortex was brought over the tubes 2 and 3 it developed a momentary bifurcation into the neighbouring tubes 1 and 4, the bifurcation being of such short duration as to be difficult to see.

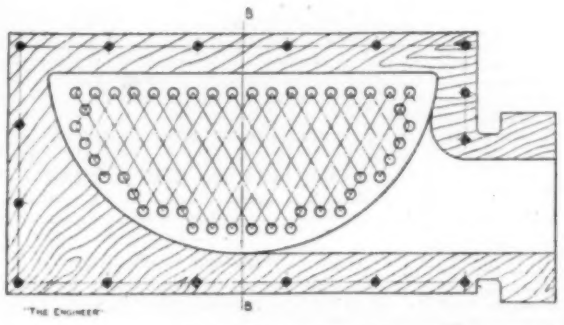
The apparatus was next modified for continuous working in order to ascertain if pitting of the tubes could actually be produced in this manner. (The arrangement of the apparatus is illustrated in Fig. 3.) The glass tubes were replaced by tubes of brass, continuous for the first 12ft. of their length, and then extended to 15ft. by attached 3ft. lengths of similar brass tube. A solenoid, with a make-and-break relay, was fitted to operate the lever to oscillate the inner water box, at a rate of about 15 cycles per minute, and a motor-driven centrifugal pump and drain tank maintained a continuous circulation, the system being filled with brackish water from the river Tyne. No head was applied and the water was atmospheric temperature.

The solenoid-operated lever was so adjusted by guides and stops as to bring the vortex filament alternately over the mouths of the second and third of the four central tubes, so that a comparison of these tubes afterwards with the first and fourth, which were not subjected to the action of the central part of the vortex filament, would enable any difference in effect to be definitely attributed to this action. The apparatus was run for 1450 hours, or about two months' continuous work, after which the four tubes were taken out and the first 3ft. of each sawn in two for examination. Pitting was observed at the entry of all the four tubes, extending from about ¼in. to a few inches along the several tubes; beyond this the tubes were apparently unaffected. Fig. 5 and Fig. 6 are photographs of the tubes after the experiment. In one of the tubes several pits penetrated about halfway through the thickness of the tube. There appeared to be very little difference in the amount of pitting in the two tubes subjected to the vortex filament, and those subjected only to the rapid transverse flow of water across their mouths.

The experiments will, however, be continued with varied conditions, including transfer of heat cross the tubes to the water as in ordinary condenser practice, and it is hoped that these may throw further light upon the subject and produce experimentally the erosion of the tubes in the central portions of their length.

In order to investigate the character of the regional disturbances occurring in a water box of usual type a further experiment was made. A model water box—Fig. 7—was constructed, about a quarter full size of an actual condenser box, with a tube plate for one hundred tubes of ¼in. diameter. These tubes were bent and spread out in groups as shown in the illustration Fig. 4, so that the discharge from each tube could be observed. The water box was fitted with a glass front. Town water was used, which was circulated by a centrifugal pump. The velocity in the tubes was about the same as in an ordinary condenser, *i.e.*, about 8ft. per second. The tubes being of different lengths retarders were fitted near their mouths to give a discharge equivalent to tubes of 15ft. length, and to maintain the standard velocity in all the tubes. Regions of strong turbulence were distinctly observed in the water box, and the vortex centres were seen to rapidly move from tube to tube over certain areas. The discharge from some of the tubes was found to show sudden variation; this variation corresponded, as regards the tube positions, with the vortex motion in the box, although the sudden drop of velocity was only about one-half that observed in the previous experiments with the circular water box. It, however, must be borne in mind that the vortices, in relation to the size of tubes, would only be of about one-quarter the size they would be in an average full-sized condenser, and also smaller than the single vortex in the circular water box experiments.

In conclusion, it is suggested that the experiments, as far as they have been carried out, seem to lead towards the view that one of the chief causes of the erosion of condenser tubes may lie in the turbulent motion of the water in the water box of the condenser, and that this cause could be mitigated by enlarging the area of the inlet passages so as to reduce the velocity of the water as much as possible before entering the box, or entirely removed by arranging in the water box a grid of suitable mesh and with passages of depth somewhat greater than their width. Fig. 8 shows such a proposal. By the passage of the water through this grid such turbulence is practically destroyed. Grids of this kind have been tried in conjunction with the experimental apparatus of Fig. 1 and 7, and it is found that with such a grid, when the whirl chamber is moved across the tube plate exactly as before, the velocity at the discharge end of the tubes remains perfectly steady, and no vortex motion is visible in the box either behind or in front of the grid.



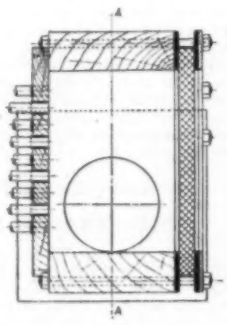


FIG. 7—ARRANGEMENT OF MODEL WATER BOX

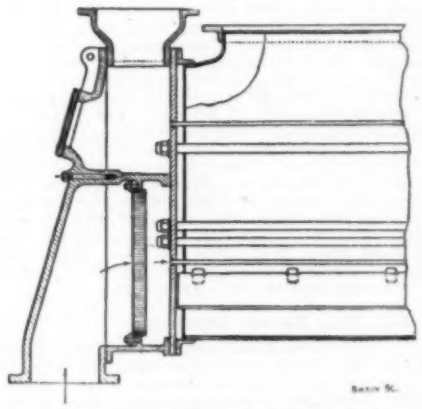


FIG. 8—GRID FITTED IN WATER BOX

South African Engineering Notes.

Potgietersrust Platinums.

From the extent of the development and the vigour with which operations are being carried on, and, equally important, the good and regular yield of platinoids, it seems most probable that the Potgietersrust Platinums, Ltd., will have a long and prosperous life. In March, 1926, there was hardly a sign of any mining material or plant on its properties, although a large sum of money had been spent in prospecting and exploratory work. To-day the pilot plant is in full swing. It consists of three Stirling boilers, 250 horse-power each, a twenty-seven drill Walker compressor, from which run the necessary air mains to the nearby workings, for the service of the pumps and jack hammers. Then there are a 350-kilowatt high-speed engine with alternator, condensing

plant, and switchboard complete. This serves the mill motors. In two large wood and iron buildings crushing, milling and concentration go on day and night. In another building is housed a 22ft. by 5ft. tube mill with a 100 horse-power Parkinson motor for driving it. From the tube mill the pulp passes to a battery of eighteen flotation cells. The finished product consists of a mixture of nickel and copper sulphides with the platinum contents of the ore associated with the nickel. About 90 tons of ore are crushed daily, the average grade being 7·8 dwt. platinoids, of which 3·3 dwt. represents the platinum content, the remainder being chiefly palladium. Large quantities of concentrates have been shipped to Europe for treatment, and the future disposal of concentrates depends on the results obtained from these experimental shipments. The company's reduction plant is at present recovering over 65 per cent. of the platinoids. It has been stated by the chairman of the directors that experiments conducted in Germany have indicated that an extraction of over 80 per cent. can be obtained. Up to now approximately 100 Europeans and 900 natives are employed, but when the company replaces the present small pilot plant by the big plant planned, which is to be capable of dealing with many thousands of tons monthly, the labour force will, of course, be increased many fold.

Electric Lighting of Trains.

A conference of the various system and divisional electrical officers of the South African railways took place at Johannesburg recently under the chairmanship of the Chief Electrical Engineer, Mr. T. P. Pask, M.I.E.E. The subject discussed was the lighting of trains by electricity, and as a result of the discussions a number of recommendations were drafted for submission to the railway managements. Should these recommendations be acted upon it is anticipated that the cost of the electric lighting of the rolling stock will be materially lessened. The importance of the matter is made evident by the following facts. The South African Railways and Harbours Administration has expended a sum approaching £1,000,000 on electric generating, storage, and lighting equipments, together with the necessary workshops and apparatus for maintaining these equipments in approximately 3250 units of coaching stock. The equipments are comprised, roughly, of 2140 dynamos with auxiliary apparatus; 60,000 accumulators, made up into batteries; 60,000 light fittings; 80,000 lamps; 45,000 switches; 60,000 safety fuses; 500 fans; 300 bell and several telephone installations; and 400 miles of copper wires and cables. The approximate cost per annum for the maintenance and upkeep of equipment in running service is £80,000, and heavy maintenance work is carried out at nine stations. In addition to the lighting of the coaching stock, steam locomotives to the number of 690 have turbo-generator headlighting sets installed on them, and 122 locomotives have a system of headlighting effected from storage batteries. The capital value of these headlighting sets exceeds £60,000, and the annual maintenance and upkeep costs are approximately £15,000.

Iron Ore Deposits of the Union.

Professor G. H. Stanley, in the course of a discussion at a meeting of the Chemical, Metallurgical and Mining Society of South Africa recently, stated that the rate at which iron ore resources were being exhausted was so tremendous that serious disquietude was felt in some countries. South Africa might become the second largest supplier in the world. In South Africa they were very favourably situated with regard to raw materials for a prospective iron and steel industry. The Pretoria series of iron ore deposit extended for 70 miles. There the iron ore occurrence was 50 per cent. metallic iron. Further north there was an occurrence of very nearly pure hematite containing almost 70 per cent. iron, and the quantity ran into millions of tons. The best coke in South Africa was obtainable from Natal, and it ranked with the highest grades overseas. The purest limestone was at Taungs, and it ran into several millions of tons. They had, too, unlimited quantities of magnesium limestone; while there was also large deposits of manganese ore.

Cape Town Harbour Extensions.

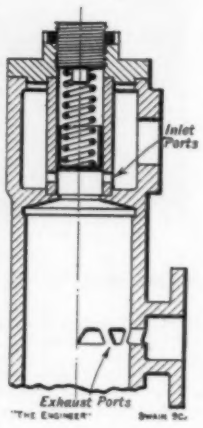
Cape Town Docks are in course of being increased to more than double their present size. When the extensions are finished, the world's biggest liners and battleships will be comfortably accommodated, and Cape Town will rank as one of the finest and most up-to-date harbours south of the equator. The harbour extension consists of the construction of a large new basin, the area of which will be over 2½ times the combined areas of the present Victoria and Alfred basins, and the accompanying berths, warehouses, and arrangements for handling cargo. The area of the Victoria basin is 67 acres and of the Alfred basin 8½ acres, while the area of the new dock will be 196 acres. The new dock adjoins the Victoria basin, and is on the city side; that is, further towards the land end of the bay, and more remote from the Atlantic Ocean. The South Arm of the Victoria basin is being widened to 700ft. and the new portion will be one of the quays of the new dock. The present portion of the scheme being carried out only contemplates the provision of berthing accommodation alongside this quay, which will give accommodation for five more large ships, each nearly 600ft. long, with up-to-date warehouses on both sides of the quay, railway tracks and main roads running between the two rows of buildings.

The fiercest gales affecting the harbour entrance are experienced from the north to the north-westerly quarter, so that in order to protect the new basin, the breakwater is to be extended another 500ft. This work was commenced in January, 1926, and so far the blockwork runs out 195ft., 155ft. of the wall being completed. To afford shelter from the south-east for ships lying alongside the new quay part, a random block mole is being laid, a 20-ton crane being engaged constantly in dropping load after load of 6½-ton concrete blocks. The base of this mole is only a little to the west of Adderley-street, the principal street of the city. The mole will at the same time form the outer side of the quay which, under the future extension programme, will eventually be built to accommodate a still larger number of vessels.

At the present time ships working cargo on the South Arm are forced to use their own derricks—a very slow method of loading and discharging. It has therefore been decided to supply fourteen 4-ton and two 15-ton cranes, which will greatly assist in the speeding up of handling cargo. Four of these are in course of erection. The additional accommodation for shipping in the harbour naturally calls for a more extensive system of railway transport, and to obtain the necessary ground much reclamation work is proceeding. The old warehouses on the South Pier are being demolished, and two-storey new ones erected, all modern improvements being incorporated. A coaling jetty to be used for loading barges is being erected in the Alfred basin parallel to the floating dock. It was only begun in November, 1926, and so far one pier is completed, and with the delivery of the steel work it is expected that rapid progress will be made with the remainder. These piers will eventually be connected to each other by steel spans to form the jetty—a great improvement on the present coaling arrangements.

A Small Automatic Steam Engine.

In a recent number of the *V.D.I. Journal*, a description was given of a new type of small automatic steam engine, which is fitted with a novel and very simple valve gear. We show a section through the engine in the accompanying illustration. In getting out the design there was no question of working with a high steam economy, for the purpose of the unit was to drive fans, such as are used in circulating heated air in factories or with small drying installations, where the exhaust steam can be usefully employed for heating purposes. The engine referred to has a designed output of 1·2 B.H.P., and it runs at a normal speed of 1400 r.p.m. when supplied with steam at 85 lb. pressure. The set weighs, we understand, only 66 lb., which is comparable with the weight of a direct-current motor of equal output. A feature of the design is the high speed which can be carried up to 2000 r.p.m.



Our illustration shows clearly the very simple character of the valve gear. It will be seen that the main cylinder liner is furnished with exhaust ports, such as are used on a uniflow engine. Steam enters the cylinder through inlet ports, which are formed in the walls of the control valve liner. There are only two moving parts in the valve gear, namely, a piston and spring. When compression takes place in the main cylinder the central piston is moved upwards against the spring, and the inlet ports are opened, the mass of the piston and spring being so proportioned that a certain amount of overrun is obtained. The working stroke then begins, and steam enters the cylinder until the supply is cut off by the valve on the return stroke of the spring. As the speed of the engine rises, the piston and spring are gradually brought up to a state of resonance, at which the engine runs at a maximum speed, which is not exceeded. It will be noted that means are provided for adjusting the compression on the spring, which enables, it is stated, the speed of the engine to be regulated within the required limits without having recourse to a governor. The engine we have briefly described is made by the Resonanz-Dampfmotor G.m.b.H., Sulzbach, near Saarbrücken, Germany.

THE FARADAY SOCIETY.

A general discussion on "The Theory of Strong Electrolytes" will be held in the Department of Biochemistry of the University Museum, Oxford, on April 22nd and 23rd, 1927, under the chairmanship of Professor C. H. Desch, F.R.S. The following is a programme of the papers:—

Part I.: "Mobilities of Ions": On the Friday, from 3.30–5 and from 5.45–7.15 p.m. (1) Introductory paper, "Report on Conductivity of Strong Electrolytes in Dilute Solutions," by P. Debye, communicated by E. Hückel; (2) report on a "Revision of the Conductivity Theory," by L. Onsager; (3) "Refractometric Evidence for the Existence of Undissociated Molecules and Complex Ions in Solutions of Strong Electrolytes," by K. Fajans; (4) "Electrolytic Transference of Water, True Transference Numbers, Ionic Mobilities and Water Sheaths of the Ions," by H. Remy; (5) "Ionic Mobilities in Non-aqueous Solvents," by H. Ulich; (6) "The Mobilities of the Elementary Ions in Methyl Alcohol," by H. Hartley and H. R. Raikes; (7) "Notes on the Debye-Hückel Theory," by H. Hartley and R. P. Bell; (8) "The Ionisation of Some Typical Strong Electrolytes," by D. A. MacInnes (communicated); (9) "A Thermodynamical Study of the System Lead Chloride-Potassium Chloride-Water at 25 deg. Cent.," by A. J. Allmand and L. J. Burrage; and (10) "Note on the Occurrence of Points of Inflexion in the Concentration-Vapour Pressure Curve of Aqueous Solutions of Certain Electrolytes," by A. J. Allmand.

Part II.: "Activity": On the Saturday, from 9.30–11, from 11.30–1, and from 2.15–3.45:—(1) Introductory paper, "On the Activity of Electrolysis," by J. N. Brönsted; (2) "Strong Electrolytes in relation to Statistical Theory, in particular the Phase Integrals of Gibbs," by R. H. Fowler; (3) "Note on the Theory of Debye and Hückel," by D. L. Chapman; (4) "Anomalies in the Theory of Solutions of Strong Electrolytes," by N. Bjerrum; (5) "Mixed Solutions of Electrolytes and Non-electrolytes," by G. Scatchard; (6) "On the Thermodynamic Properties of a Few Concentrated Salt Solutions," by H. S. Harned; (7) "The Activity of Zinc Chloride in Concentrated Solution," by F. Foxton and W. J. Shutt; (8) "Influence of Salts on Solubility in Non-aqueous Solvents," by C. A. Kraus (communicated); (9) "The Use of Amalgam Electrodes for Determining Activities in Methyl Alcohol," by J. H. Wolfenden, C. P. Wright, N. L. Ross-Kane, and P. S. Buckley; (10) "The Significance of the Activity Coefficient," by Merle Randall (communicated); (11) "Methods of Calculation of Activity Coefficient," by Merle Randall (communicated); (12) "Electro-chemical Properties of Non-aqueous Solution of Strong Electrolytes," by J. R. Partington; (13) "The Definition and Characteristics of Strong Electrolytes," by T. M. Lowry; and (14) "The Activity of Hydrogen Ion in Mixed Solvents as a Function of Environment," by H. Millet.

SIXTY YEARS AGO.

On April 1st, 1867, the Emperor of the French, accompanied by his ill-starred Empress, opened the great International Exhibition in the Champ de Mars, Paris. The Exhibition, according to an article in our issue of April 5th, 1867, was bigger and in many respects more important than any which had preceded it. Indeed, it was not easy, so we wrote, to imagine how any Exhibition in the future could surpass it. It was not, however, apparently above criticism. The Emperor had given his Imperial word that the Exhibition would open on the first of April, and opened on that date it was. But from the account transmitted to us by our special representative, Mr. Robert Mallet, F.R.S., it appears that in its state of unpreparedness for the admission of the public it greatly surpassed what experience teaches us to regard as the usual standard reached by exhibitions on the opening day. The British section, under the direction of Mr. Henry Cole, was, it appears, much in advance of any other in the completeness of its preparations. We criticised the wisdom of introducing pictures and sculpture into industrial exhibitions. They provided, we said, an attractive but distracting element. They increased the turnstile figures, but did little or nothing to promote the industrial value of the undertaking. That value, too, we maintained, was seriously lessened by the fact that no arrangements had been made to supplement the catalogues and jurors' reports by the work of an organised department of scientific men empowered to study and discover among the exhibits new or valuable materials or objects of importance to special trades, interests or countries. Our own Exhibition of 1862 had provided a regrettable example of failure "to husband the garnered knowledge in a complete and orderly form for future use and profit." Industrial exhibitions had been begun "in a wise, right and noble spirit" in 1851 in this country, and had been continued by various nations. Even by 1867, however, it was being felt that they were being overdone. A tendency was being shown to subordinate the genuine and true objects of industrial exhibitions to financial ends, and to mere external vastness and display. We expressed the hope that when the Paris Exhibition closed in the autumn one decade or two would be allowed to pass before "another great stocktaking of the world's wealth and of human power over it" was attempted. The Paris exhibition building, it may be added, was arranged on a novel plan. It was a large circular structure divided into annular zones intersected by radial passages. The exhibits were so arranged, or were intended to be so arranged, that circumferential transit on the part of the visitor took him past similar products from different countries, while radial transit enabled him to inspect all the exhibits of any one nation. As was to be expected, the plan, satisfactory in theory, broke down in practice, the inner zones being excessively crowded with exhibits, and the outer zones being sparsely occupied.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HIGH MOTOR SPEEDS.

Sir,—It is the common experience of most motorists that up to, say, 60 miles per hour the greater the speed the easier the steering.

Recently in respect of the highest speeds attained we are informed—true, by the lay Press chiefly—that a "fourth dimensional" force tends to evince itself after a certain critical velocity is attained, and whether this is so in fact or whether it is merely a figment of the imagination of the "Fourth Estate" only the drivers themselves can say.

If, however, it does so evince itself in fact, is it not barely possible that a mass weighing some 5 tons and moving at some 200 miles per hour may establish a stability of its direction of travel in a manner analogous to that of the gyroscope?

If this is a tenable theory, its resistance to departure from the vertical plane of its direction of travel would set up a lateral force due to the earth's rotation beneath it if the car is being driven north or south, and I believe that both Pendine and Daytona beaches run that way, though I am unsure of this.

In such case it would be interesting to test whether any tendency of the car to "chase its tail" varies in direction of rotation with the northerly or southerly course, and if any such proof is attained then all speed records of the future should clearly be run due east or due west as the case may be.

Possibly the suggestion is as "bizarre" as unnecessary, but strange things begin to happen when known factors are exceeded, and I offer the above in all diffidence, though in all good faith.

Leeds, March 31st. I. Wonder.

[It is undoubtedly true that on a north-south course gyroscopic action is set up in the wheels, but even at 200 miles per hour the tendency for the axles to set themselves parallel with the earth's polar axis is so small as to be negligible in its effect on the steering. There is no gyroscopic action so far as the general body of the car, apart from the wheels and other rotary members, is concerned. On the other hand, an east-west course would introduce a definite variation in the reaction of the car on the ground, the "weight" of the car being less on an east-west course than on a west-east course. At 200 miles per hour the difference, could it be measured on a weighbridge, would be quite perceptible.—Ed. The E.]

A New Digging and Loading Machine.

A NEW type of machine intended for digging and loading sand, gravel, coal and crushed stone has been put upon the market by Spencer (Melksham), Ltd., of Melksham, Wilts. The machine, which is self-propelling and to which the name of Digyloader has been applied by its makers, is illustrated in the accompanying engravings. It has a capacity of approximately 1 cubic yard per minute when working on free-running material, and it can deal with

FIG. 1—THE DIGYLOADER WITH SWIVEL DELIVERY SHOOT

crushed stone that will pass through a 2½in. ring or coal with occasional 6in. lumps.

As shown in our illustrations, the machine is mounted on and operated by a standard Fordson tractor, but it can, we understand, be arranged so as to be driven by a 10 B.H.P. electric motor.

The elevator buckets are of pressed steel, with arched lips and they measure 16½in. by 12in. The chain is of the

FIG. 2—THE MACHINE OPERATING ON A PILE

maker's combination link type, the links having a 3in. pitch. The height of the delivery point is 10ft. 3in. above the ground, and the material is delivered 3ft. 6in. from the back of the tractor, or, if an adjustable swivel shoot, which can be attached to the delivery spout—see Fig. 1—be employed, the material may be delivered up to 8ft. from the back of the tractor.

The rear wheels of the tractor are 42in. in diameter by

FIG. 3—THE BUCKET FEEDING MECHANISM

12in. wide on the tread, and they are cleated, while the front wheels are 24in. in diameter by 10in. wide on the tread. The drive is effected by steel roller chains working on machine-cut sprockets.

The digger is furnished with self-traversing gear having a speed of about 2ft. per minute. This gear is so arranged that it does not interfere with the gear-box of the tractor, and it can be operated from the ground, if required. The motion is imparted to the back wheels by means of an excentric-driven pawl, the shaft being driven from the power take-off of the tractor. The pawl engages with a ratchet wheel, which is fastened to the back wheels of the tractor, and the tractor is maintained by a fixed pawl. The machine also has a self-feeding gear which feed the material from the heap into the buckets and cuts a track 5ft. wide. The elevator can be hoisted into a horizontal position for travelling, and the position of the lower buckets can be varied within small limits, when working to correspond with the unevenness of the ground. The machine is not, however, designed to dig trenches, but to clear up heaps from the ground.

Although it is not fitted in the standard machine, a special cutter gear attachment can be added if required. This attachment consists of a cutter bar on which are mounted steel castings that hold cutter knives, in a manner somewhat similar to that employed with the ordinary coal cutter bar. The attachment is intended for removing the overburden on such materials as china clay or gravel. It chops up the material, which falls on to the feed gear and is fed by the latter to the buckets.

When housed for travelling, the machine is 9ft. 9in. high, and it will pass through a doorway 10ft. high and 7ft. wide. Its total weight is about 12,500 lb., or just over 5½ tons. It may be driven about from place to place by the ordinary gears of the tractor, and all the motions can be controlled from the seat on the tractor.

Lubrication.*

By W. R. ORMANDY, D.Sc., F.I.C.

(*Concluded from page 362.*)

FROM the practical standpoint the problem of lubrication is bound up with the question as to whether "oiliness" is a real specific property of bodies or not. The view might well be taken that the conception of this property is a mere vague will-o'-the-wisp idea fostered chiefly by oil salesmen. Certainly no means has yet been devised for the measurement of "oiliness." On the other hand, it may very plausibly be argued that two oils which possess a very similar measure of properties such as viscosity and density may yet behave very differently as lubricants. Bingham instances the remarkable difference between lard oil and a mineral oil on the action of an Armstrong parting tool in cutting off discs from a rod of soft steel 1¼in. in diameter. Thirty discs were cut with lard oil and the last was as good as the first. On substituting mineral oil heating set in at once, the discs were very rough and the tool lost its edge, failing completely to cut off a fourth disc. The function of the oil in this case is to lubricate the chip along the tool, and the result shows clearly that an oil having a high adhesion is necessary under such heavy duty. This property of adhesion is probably at the basis of the conception of oiliness, and assumes enormous importance when the lubricating film thickness falls to an extremely low value. Much work has been done in connection with lubricant films of mono-molecular thickness.† Such films possess truly remarkable properties in reducing the friction between solid bodies. It is likely that if the two surfaces were not contaminated by the layer of lubricant, *i.e.*, that if they were really chemically clean, welding would occur at once, and any subsequent motion would be governed by the plastic flow of the material in question. In any consideration of "oiliness" the question of solid materials must not altogether be overlooked. The unctuous feel of boric acid, talc, clay, graphite, &c., indicates a very low coefficient of friction between their crystal planes. Of anti-friction materials the oldest and perhaps the best is ice.

It is commonly stated that the laws governing the frictional resistance in a bearing vary from the laws of solid friction for a very imperfectly lubricated surface to the laws of viscous liquid flow when the lubrication is abundant. Experiments have usually been carried out so that the conditions for one or the other set of laws obtain to a preponderating extent. For example, the work of Hardy deals chiefly with lubricating films of extreme tenuity, whilst other workers develop films of considerable thickness and get steady results by immersing the bearing in a bath of the lubricating oil. It may be doubted whether conditions of limiting lubrication occur in practice except very rarely. For example, in the motor car we may be concerned with oil films of limiting thickness on starting up after long standing, but only momentarily.

Recent experiments by A. E. Becker on the thickness of oil films between the plane surfaces of two discs, one fixed and one rotating, give results varying from 2 to 20 wavelengths of sodium light.‡ These are of an order very different from the mono-molecular layers of Langmuir, Hardy, &c.

It will be of interest to consider briefly the laws underlying the motion of bodies in viscous liquids, starting with unlimited amounts of liquids and proceeding to the other limit of vanishingly small amounts.

When the rate of shearing of the liquid is small the frictional resistance is proportional to the viscosity of the liquid and the rate of shear. For spheres falling under gravity through a viscous liquid a terminal velocity is reached which is given by Stoke's well-known formula so long as the velocity is not greater than a certain critical value. For example, Rayleigh has calculated that for a sphere of 1 mm. radius the terminal velocity should not exceed 0·18 cm. per second. The British Engineering Standards Association has standardised a falling sphere viscosimeter. For discs a slight variation of Stoke's law holds.

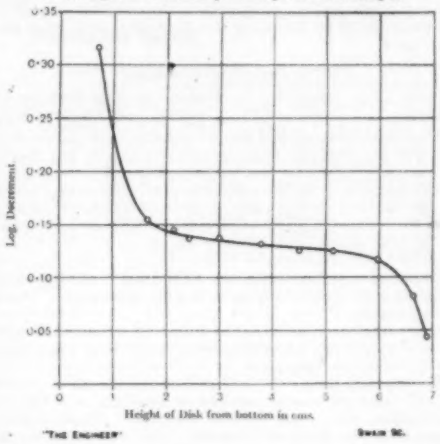
$$\left.\begin{array}{ll} \text{Spheres:} & 6\pi r\eta v = W \\ \text{Discs:} & 16 r\eta v = W \end{array}\right\} W = \text{apparent wt. of falling body.}$$

Some experiments made with discs of celluloid of equal thickness in sugar solution showed that the linear law was followed up to a velocity of 0·21 cm. per second, after which the frictional resistance increased more rapidly than the velocity. In general, if the viscous forces are large compared with the forces producing motion the viscous resistance is proportional to the velocity. A light vane moving under the torsional couple of its suspending wire exactly follows this law, as shown by the agreement of the calculated and observed motion.

The foregoing results apply to motion in an ocean of fluid. As the amount of fluid becomes more restricted the influence of the walls of the containing vessel begins to be felt. In the falling sphere viscosimeter a very large correction is usually necessary on this account. The effect is also shown in the sedimentation of precipitates or minerals. The curve of sedimentation of talc, for example, consists of three main parts: there is the portion in which the particles get up speed and approach the terminal steady velocity; this is maintained fairly steadily in the middle part of the curve; and finally there is a slowing down as the plates of talc feel the effect of the bottom of the vessel and the packing of the particles themselves. The rate of fall of a disc as the layer of liquid thins out under it will be considered shortly.

A corresponding effect is found in observations on the decrement of a disc oscillating horizontally under the torsion of a suspending wire central and normal to the plane of the disc. As the disc is caused to approach the bottom of the vessel containing the liquid, the decrement, which is a measure of the viscous resistance experienced by the disc, increases. The curve, Fig. 3, shows the variation in

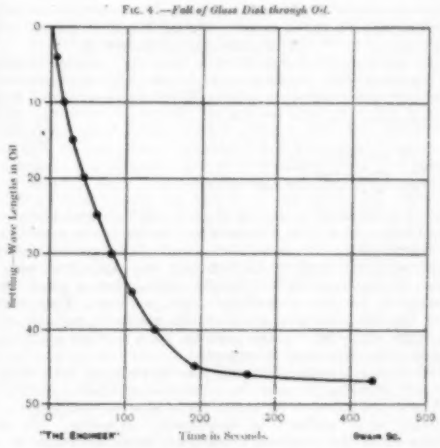
FIG. 3.—*Logarithmic Decrement of Oscillating Disk in Lubricating Oil*



the logarithmic decrement of a disc in 7·0 cm. of lubricating oil for various depths of liquid under the disc. Near the surface the resistance falls off rapidly, but as the bottom is approached it appears to be rising to an infinite value. Certain workers have, however, found that in solutions where concentration occurs in the surface layer —*e.g.*, saponin solution—very high viscosities may be found near such a surface. In other cases a superficial layer may produce the effect of a very much lower viscous resistance. The Southern Pacific Railroad found that in oil pumping the use of a rifled pipe line and a little water in the oil enabled eight to ten times as much oil to be pumped through a pipe of given diameter with the same expenditure of energy.

The equations of fall of spheres and discs through thin

FIG. 4.—*Fall of Glass Disk through Oil.*



films of viscous fluid have been worked out by Professor G. I. Taylor.

For a plane disc of radius a and weight $m\,g$ the time of fall is given by

$$T = \frac{3\,\pi\,\eta\,a^4}{4\,m\,g}\left(\frac{1}{h_1^3} - \frac{1}{h_2^3}\right)$$

where h_1 = initial height,
h_2 = final height.

For spherical surfaces the rate of fall is, in general, very much greater.

Attempts were made to verify the equation for a plane disc in two ways. In the first a plano-convex lens was placed plane side down in a pool of transformer oil on an optically worked plate of glass. With sodium light broad interference fringes were seen, indicating that the plane surface of the lens was not truly plane. The rate of passage of these fringes gave a measure of the fall of the lens through the oil film. The experiment was somewhat difficult owing to the faintness of the fringes and their habit of disappearing on slight provocation. One of the few complete curves obtained is shown in Fig. 4. It will be noticed that there is a sudden check in the fall after

* Joint meeting of the Institution of Mechanical Engineers with the Society of Chemical Industry (Chemical Engineering Group).

† Langmuir (1920) found that paraffin oil film can be washed from glass by running water, but oleic acid cannot so be removed.

‡ Taken as 0·59 × 10⁻⁴ cm.

about 45 wavelengths* fall. This is probably due to the irregularities of the two surfaces used, probably of the order of a few wavelenghts, so that the film is prevented from thinning indefinitely. It would appear fairly obvious that on the average an irregular film some wavelengths thick is left after long settling. It is likely that the initial portion of the curve follows Taylor's equation. If the equation be put in the form

$$T = \text{const.} \left\{ 1/h_1^2 - 1/(h_1 - x)^2 \right\}$$

where x is the distance fallen, on development it will be found that six points on the observed curve can be fitted to the equation, so that the test would not be rigorous.

In a second method two stainless steel discs prepared by Messrs. Bellingham and Stanley were employed, each having one surface ground and polished to a moderately good optical plane. The larger disc of 5 cm. was placed with its plane surface accurately level and the smaller disc of 3 cm. diameter and of mass 33·1 grammes was placed in a pool of oil on the lower disc. The capacity of the condenser so formed was measured at a frequency of 2500 cycles, and the direct-current resistance of the oil film measured by suitable means. The resistance measures may be quickly dismissed. It was found that the resistance was either so high as to be rather outside the means of measurement at hand or else of the order of 1000 ohms. The change from high to low was extremely sudden, and at the low resistance no capacity measurement could be taken.

The capacity measurements were rather more informative. One set of results is given below, the oil film thickness being calculated by assuming the dielectric constant of the oil to be 2.

Oil :—Paraffinum Liquidum.

Time, mins.	Capacity μ F.	Resistance, ohms.	Film thickness in wavelengths D line.
0	0·0005	$>10^7$	166
4	0·0010	,,	83
6	0·0011	,,	75
13	0·0015	,,	55
20	0·0018	,,	46
29	0·0020	,,	42
35	0·0022	,,	38
36	?	1200	—

The highest capacity observed with paraffinum liquidum was 0·01 μ F, corresponding to a film thickness of about 8 wavelengths.

It is fairly obvious from the foregoing results that long before a film of limiting thickness is formed the discs come in " contact " at some place.

The low resistance of oil film between the discs at the area of contact was somewhat surprising, and further experiments were made in this direction. These experiments took the form of measuring the resistance of the film of oil left between mercury and a metal vessel. Dishes of copper and nickel were used and a platinum crucible. In all cases the resistances found were of a very small order, usually a small fraction of an ohm. With copper it was difficult to be sure that no amalgamation occurred, but in the case of platinum and nickel this possibility is practically eliminated. The amount of the current used in measuring the resistances was varied from $^1/_{10}$ of a milliampère up to several ampères without any noticeable difference in the results. The following specimen results are with 5 c.c. of mercury in a hemispherical nickel dish 4 cm. diameter :—

Paraffinum liquidum.	Ohms.
After standing few minutes	1·10
Mercury shaken round	0·28
After standing overnight	0·04
Mercury shaken round	0·06

If one calculates on the basis of Ohm's law and the roughly known conductivity of the oil, the thickness of the oil film works out at 10^{-11} cm., a quite impossible result.

Still more surprising is the fact that very similar results are obtained with paraffin wax, melted and then allowed to solidify with the mercury in. With the same nickel dish the following were the results :—

	Ohms.
Wax cooled quickly	3·3
Wax cooled slowly	0·01
Mercury poured out and back	0·01

These low resistance films will pass current apparently to any extent. It will be remembered in this connection that the terminals of accumulators are often greased with petroleum jelly without introducing any apparent resistance. In the case of the paraffin wax, when a glass was substituted for the metal dish, the resultant films were quite visible. An attempt is being made to prepare the wax films on a sheet plane parallel glass so that its thickness may be determined optically.

Although the work of Hardy was carried out with optically true surfaces, it must be remembered that, compared with the thicknesses of mono-molecular layers, even an optically true surface is immensely irregular. If we assume that the surfaces employed were accurate to a fifth of a wavelength of sodium light, this means that the unevennesses were of the order of one thousand A, whereas the length of the molecule of stearic acid with 18 carbon atoms is about 25 A. The unevennesses, then, are of the order of 40 molecular lengths. Two optically true surfaces may, in fact, be resting on three points or on a considerable number of points, but certainly the whole areas are for the most part not in contact. If, in fact, the surfaces which are most nearly in contact are separated by mono-molecular layers, we have to conclude that these layers are excellent conductors of electricity.

There is some indication in Hardy's work that the state of polish affects the end results, and this is to be expected if we agree with Beilby's conclusions that polishing is nothing more or less than the conversion of a crystalline surface into an amorphous or glass-like one, for we have every reason to believe that the forces available at a surface of amorphous material will be more intense than those available at a crystalline surface.

Viscosity.—Having dealt thus briefly with one aspect of the lubrication problem it may be of interest to turn to other aspects having a more immediate and practical bearing on every-day problems. The engineer may say that he is comparatively little interested in the problems of limiting lubrication, since he designs his bearings in such a way that an oil film of adequate thickness is provided, and that it is the behaviour of this film which interests him. How successful the engineer is in bringing about complete separation of the metallic surfaces by lubrication media is evidenced by an examination of the average lubricating oil taken from any bearing. Viscosity is clearly very important, and oils which have the flattest viscosity curve with change of temperature will be preferred. However different may be the viscosity of mineral lubricating oils at ordinary temperatures, the viscosity curves approach very closely as temperatures get higher, until at 200 deg. Fah. and still more at 300 deg. Fah. differences become comparatively small. Generally speaking, oils with a low specific gravity have flatter temperature viscosity curves than those of higher gravity, though this is by no means always the case, as much depends on methods and degrees of refining.

Volatility and Flashpoint.—The flashpoint of a lubricating oil may be a very mistaken guide, since the presence of mere traces of volatile bodies affect the flashpoint greatly ; but a high flashpoint, having regard to the specific gravity and viscosity of the sample, is some evidence of a narrow cut in the distillation range. Volatility, or loss on heating to a predetermined temperature, taken in conjunction with the nature of the residual oil is a very valuable test when the oil is going to be subjected to high temperatures under oxidising conditions.

Resistance to Oxidisation.—All mineral lubricating oils adsorb oxygen, and the rate of this adsorption varies very greatly with the nature of the oil, the degree of refinement, the temperature, and the presence of metallic bodies which act as catalysts. Most lubricating oils are used under conditions where a temperature rise in some degree is to be expected, and almost always in contact with oxygen of the air. In the crank case of an internal combustion engine almost ideal conditions exist for the rapid oxidisation of lubricating oil, for here there are high temperatures, constant renewal of the air, and oil in a finely divided state. Moore has pointed out that in his experience the most frequent cause of damage due to defective lubrication in modern machinery arises from the result of oil oxidisation. It is not that the oxidised oil loses much, if any, oiliness for a considerable time, but the products of oxidisation may be asphaltic-like bodies which are insoluble in the oil and so lead to stoppage of the oil ducts. Frequently the result of oxidisation is the production of acid bodies which cause the oil to form a thick emulsion with comparatively small quantities of water, and this emulsion will not pass readily through the circulating system employed. Generally, in order to test an oil for its behaviour as regards oxidisation, it is heated to a given temperature and air or oxygen blown through for a given time. The oil is then tested for the amount of asphaltic matter which has been formed, and in some countries the amount of acid bodies formed is determined instead or as well as the asphaltic bodies. The temperatures so employed are in the neighbourhood of 110 deg. to 150 deg. Cent. in most cases, though much higher temperatures are employed in certain specific tests. Moore makes a very interesting observation that the sludge produced in the oils which he tested bears a close relationship to the sulphur content of the oil. Generally those oils which gave high sludge tests also became very viscous under oxidising conditions. There seemed also to be some connection between the Air Board specification coke test and the sludge that was formed. Again speaking generally, it would seem that the asphaltic base oils contain the most sulphur and are most amenable to attack by oxygen under the conditions of the sludging test, and that the paraffin base oils such as those of Pennsylvania and the Russian oils are much more resistant. It may be argued that, however valuable a sludge or high-temperature oxidisation test may be for transformer oils and for crank case oils, it is of little value when applied to oils which are to be used under less strenuous conditions where the temperature reached will not be much above atmospheric. Obviously a vast amount of work remains to be done. We know that any crude lubricating oil, whether paraffin base or asphaltic base, can be so highly refined that paraffinum liquidum is obtained, and this is a poor lubricant. Dunstan and Thole have pointed out that the best lubricants are the bodies which can be removed by over-treatment with sulphuric acid in the refining process. It is possible to refine an oil to such a degree that blowing by oxygen at a high temperature will give practically no sludge, but the resulting oil may be heavily charged with acid bodies and peroxides and have acquired such a nature that it will immediately emulsify in contact with water. Moreover, the acid bodies so produced will act corrosively on many metals and on all textiles, and will tend also to the formation of resinous bodies which may become insoluble.

It has been stated that one-quarter of the lubricating oil production of the world is used in motor car crank cases, and as the efficiency of the modern high-speed internal combustion engine increases, demands upon the lubricating oil also increase. Hoblyn, in a very interesting paper before the Institution of Petroleum Technologists, showed that if small quantities of oils be heated in porcelain dishes to 250 deg. Cent. under conditions allowing of the entry of air, there comes a time when all the oils hitherto homogeneous under the microscope become heterogeneous and that gradually dark-coloured insoluble bodies separate. He claims that the length of time that elapses before the dark particles become evident under the microscope is a measure of the suitability of the oil for crank case use, and adds that the laboratory results have been borne out in long road experience. It should be recognised, however, that the engines used by Mr. Hoblyn run very hot and are unusually highly stressed.

It has been shown that oils can be too much as well as too little refined, and that oxidisation is more rapid with over-refined oils than with those less highly treated. Again, the rate of oxidisation is influenced by the nature of the vessel in which the oxidisation test is carried out. Iron, copper, lead and zinc all influence the rate of oxidisation greatly but in very different degree. It is even possible to mark the different influence of copper that has been cleaned by mechanical rubbing and that which has been cleaned by reduction after heating in methyl alcohol. There is no doubt that finely divided metals greatly increase the tendency of oils to oxidise, and continuous filtration of crank case oils for the removal of metallic particles has been proved to lead to greatly increased life of the oil and of the bearing.

It is quite obvious from even such a superficial consideration of some aspects of the lubrication problem that a solution will not be found by the chemists or the physicists or the engineer working alone, nor is it likely that any fundamental knowledge will arise without the co-operation of all three acting together with the oil producer. We want to know if the characteristics of the oil are conditioned by Nature, or that it is impossible by any sort of refining to get from, say, an asphaltic base oil a product which will replace another produced from a paraffin base oil. Does the sulphur present in a lubricating oil act through its compounds to bring about easy oxidisation, or is the sulphur merely an indication of the presence of other organic bodies, themselves readily oxidisable ? To what degree should refinement be carried to get an optimum product, and what are the bodies which, being deleterious owing to their unstable chemical nature, have to be removed ? Have we to regard sulphuric acid treatment as the last word in oil refining ? Must an asphaltic base oil after refining still tend more towards the production of asphaltic bodies on oxidisation than paraffin base oils ? Are some metals such active catalysers in the finely divided state that it would be well to eliminate them from bearing metals ?

If they serve no other purpose, the foregoing remarks at least point to the many directions in which investigations ought to be carried out before it can be said that we have anything like an adequate foundation of knowledge in this important subject of lubrication. The discursive nature of the paper is to some extent due to the desire to show as far as possible the various directions in which research is still needed. Further research on lubrication should, the author thinks, be undertaken in such co-operation as may be possible with the Department of Scientific and Industrial Research. The Research Department appointed a Committee on the subject of lubrication, which spent a good deal of time and money in getting together a very exhaustive report on the literature of the subject, and this alone is a very valuable asset to anyone else about to embark upon a research programme. The Research Department Committee's report eventually led to that fundamental work of Hardy which has been so frequently referred to in the present paper. The industrial world requires all the lubricating oil which is available, produced from all sorts of crudes. The producers are just as anxious as the user to improve their products and to know what should and what should not constitute a good lubricating oil, and would welcome any help which may lead to improved methods of removing the unwanted bodies without at the same time removing those that are desirable. From a purely economic standpoint the best oils, namely, those which will best withstand the most strenuous conditions of use, should be retained for such use ; but the author would not go so far as to suggest that it would be easy to convince the owners of highly asphaltic crude oils that as good a product cannot be produced from their material as can be produced by some paraffin base crude, should this in fact prove to be the case. It is, at any rate, certain that any real advance on the commercial and practical side of research work on lubrication must be done to some extent in conjunction with the oil producer. It is of no use to work upon unknown material ; its source and life history are essential if fundamental results are aimed at.

The author's thanks are due to Messrs. Macmillan and Lady Beilby and to the Institution of Petroleum Technologists and Mr. Holbyn for their permission to use illustrations from published works, and above all to his assistant, Mr. E. C. Craven, for his valuable help throughout.

* *i.e.*, 45 wavelengths in oil in this case. For true distance divide by 1·462, the refractive index of the oil.

GEAR WHEELS AND PINIONS FOR ELECTRIC TRAMWAYS.

A British standard specification for gear wheels and pinions for electric tramways has just been issued by the British Engineering Standards Association. For a number of years an attempt has been made to secure standardisation in this important part of tramway equipment, and some time ago the Municipal Tramways Association invited the B.E.S.A. to make an effort in this direction. One of the difficulties to be overcome was that although the dimensions were to some extent similar, each manufacturer worked to a slightly different formula for the tooth form, in addition to making use of many different materials and heat treatments for the manufacture of the wheels. It was recognised that with the advent of high-power motors and increased speeds on tramways, it was essential to effect not only a standardisation to provide interchangeability, but to collect all available knowledge of the materials used, and committees were formed consisting of the makers of gears, representatives of the tramway undertakings, steel manufacturers and metallurgists to go into the whole matter. It is a tribute to the cordial co-operation of all these interests that the specification has been produced in so short a time.

Already a large number of gear wheels and pinions have been made to this specification, and it has been established that they are superior to those previously manufactured, proving to be very silent in operation, and showing less wear than in the past had been accepted as inevitable.

In addition to standard sizes and formulæ for tooth form, specifications of materials and heat are included for the following :—(1) Cast-hardened forged gear wheels and pinions ; (2) case-hardened cast gear wheels ; (3) " 45 " carbon steel forged gear wheels and pinions (water-hardened and tempered) ; (4) cast gear wheels (water hardened and tempered). There should therefore be no difficulty for tramway engineers to select the material best suited to their individual requirements and conditions of running.

Copies of the specification—No. 235, 1927—can be obtained from the publications department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, post free 2s. 2d.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

IT was very disappointing to iron and steel-masters and Midland industrialists generally that the second quarterly meeting of the Midland iron trade in Birmingham to-day—Thursday—should have done nothing to clarify the future trend of trade in the basic industries. Trade is still dogged by the evil consequences of last year's coal strike. Ever since the end of that dispute, when hopes of real activity and increased prosperity for the heavy trades of this district were reborn, the outlook has been obscured by the clouds of future production costs. The January quarterly meeting was expected to give at least a rough idea of the future course of prices, but it came and went without enlightenment. During this quarter the difficulties have grown, railway rates have increased and coke prices have advanced. Business throughout has been of a hand-to-mouth character, consumers not being prepared to concede the high prices asked for materials, alike raw and finished. There was a large gathering of interests on 'Change to-day, many coming from distant markets, though it was not considered likely that much big-scale business would be transacted. Those who optimistically anticipated some illumination of the future of prices at this meeting were again disappointed. True, there was a disposition manifest on the part of some producers to accept lower prices for business placed over the next quarter, though for current delivery quotations remained firm and high. Consumers hesitated to take advantage of the concessions notified, wondering whether by continuing to hold off the market they would force producers to name still lower prices. At any rate, there was no definite movement to place new business; indeed, it was reported that increased business was placed for continental supplies, though only sufficient to enable manufacturers to carry on until native producers have adjusted their prices to a level on which buyers have apparently set their minds as affording a fair basis for rebuilding the trade position. Producers whose accumulated reserves of orders are now rapidly dwindling find outlets for many classes of material becoming smaller, and unless increased freedom of contracting develops before long a considerable curtailment of production is likely during the current quarter.

The Crucial Fact.

The adjustment of iron and steel prices to the new situation is impeded by the high price of coke in an under-supplied market. Indeed, the lack of effective co-operation by the coke ovens is considered the crucial fact in the present trade situation. No one is more anxious to reduce prices than Midland ironmasters, but their production costs have increased, fuel is difficult to get and profitable production, even at to-day's selling figures, is more or less a matter of output. It has become apparent that the output of blast-furnace coke is insufficient to keep the 162 furnaces, which have resumed operations since the end of the coal strike, regularly supplied, unless smelters are prepared to outbid competitors in the market who want coke for other purposes. Blast-furnaces which have collieries and coke ovens in association with them are the masters of their own fate, but the rest are at the mercy of a small and precarious supply, the cost of which is so high that the furnaces cannot be operated at a profit on any fair assessment of expense. With the advance of 2s. per ton in coke prices over the next quarter—and it appears to have been insisted upon in most cases—Midland smelters are faced by an increase in production costs of roughly 3s. per ton. It has been impossible to put up pig iron prices to cover this latest charge, and ironmasters are in a serious dilemma. In some cases to-day they stated that production must be curtailed, as they would be selling at a loss. Yet it cannot be said that the pig iron price position is altogether strong, though smelters are obliged to resist the pressure for concessions in the present position of the industry. Northamptonshire furnaces represented at to-day's meeting were not in all instances quite so firm in maintaining quotations as those of Derbyshire, but there was no quotable change in values. Derbyshire foundry remains at £4 5s. and Northamptonshire at £4 per ton at furnaces. Forge prices cannot be defined with any precision, so widely do they vary. As low as £3 15s. was mentioned for Derbyshire and £3 10s. 6d. for Northamptonshire. Basic was quoted round £4, and East Coast hematite £4 4s. at furnaces for mixed numbers. It was intimated that that figure would be shaded for attractive business. Ironmasters regret the position, for it is considered in most quarters that if only pig iron could be produced to sell at a reasonable price, the opportunity exists for employing more furnace capacity than has been the case since the war. To this end it is absolutely necessary to have the co-operation of the coke ovens, and this not being, at the moment, forthcoming, the development of the iron and steel industry, and with it the reanimation of engineering and shipbuilding, are being seriously impeded.

Continental Pig Iron.

Continental pig iron was on offer at to-day's quarterly meeting at about £4 7s. 6d. delivered into this district. Local users are not likely to take much advantage of this material, as the long delay in the delivery of French and Belgian iron is a consideration not counter-balanced by the difference in price. It is considered probable that as the result of the deliberations of the European cartel prices will be lowered, and continental competition in pig iron may then become a serious factor.

Poor Demand for Steel.

There has been a decided contraction of business in the Midland and Staffordshire still industry, which to some extent may be attributed to the approach of the Easter holiday. Buying being confined to current needs, the "break" at the works will be felt more than usual by producers of iron and steel. Much of the accumulated arrears of work have now been worked off, and except in cases of the larger organisations employment at the mills has now become somewhat irregular. Local constructional engineers are not so busy as they were, and the orders they had to give out at to-day's meeting were for relatively small tonnages. They have still some difficulty in securing heavy joists, but most other materials are coming forward more freely. Even plate mills now promise execution within three weeks from the placing of the order. Indeed, they are in some cases diligently seeking orders. Throughout the structural branch there is a disposition to shade prices to secure employment through the coming quarter. Some plate mills to-day expressed their willingness to abate 5s. of the £8 17s. 6d. quotation under the above circumstances. Forward contracts for angles and joists could be placed at £7 15s., as against £7 17s. 6d. a week ago. The reduction of 10s. per ton in Staffordshire hoops, bringing them to £10 10s., resulted in a certain amount of increased business. There was no change in the attitude of sellers of billets, who quoted £7 firm. Many, indeed, wanted half-a-crown to 5s. above this figure. Continental billets were offered at the reduced price of £5 10s.

Galvanised Sheet Values.

Business in galvansed sheets at to-day's market could not be described as brisk, but it certainly showed improvement on recent weeks. Overseas orders, chiefly from the East, were also reported to be more numerous and, under the stimulus of increased demand, values hardened somewhat. Though the usual quotation for 24 gauge corrugateds remained at £15 5s., some mills asked an additional half-crown.

Staffordshire Iron Prices.

Staffordshire makers of wrought iron find a steady demand for chain and anchor iron, also for best grade bars for special engineering work. While this fact is pleasing, and enables them to secure the full standard price of £14 10s. for marked bars, the dulness which for months has characterised the Crown and common bar branches has caused curtailment of output and a lowering of values. Crown bars have depreciated a further half-crown, being freely offered to-day at £11 7s. 6d. There were few purchasers, however. Very little common bar iron is being made, owing to the wide difference in price between Staffordshire and Belgian material. Local makers have now reduced their quotation to £10 7s. 6d., but even at this figure it is not considered competitive. Deliveries of continental material are still being made on old contracts, but no great volume of new business is being given out in this district. The tube trade is quiet, and demand for wrought iron gas tube strip has fallen off. Some sellers in an endeavour to encourage buying are stated to have offered supplies at below the generally prevailing figure of £12 15s.

Staffordshire Pits' Peril.

An arrangement somewhat in the nature of an experiment has been come to by colliery owners and mining interests in the southern area of the South Staffordshire coalfield, as an alternative to the closing down of the Buffery, Windmill End and Waterfall-lane pumps, with the threatened flooding of the mines in the district, details of which appeared in my last letter. A meeting held last week to consider the situation which had arisen consequent upon the voluntary liquidation of the Buffery Colliery Company, which, subject to the payment by other owners of tonnage rates, had guaranteed the continuance of the Buffery and Windmill End pumping engines, shows that despite considerable differences of opinion and the difficulty of idle collieries which are not liable for any contribution, the necessity for keeping the pumps going was clearly recognised. Although it was decided to close down the Buffery pump, operations are to be maintained at Windmill End and Waterfall-lane. It is feared that these two engines will be insufficient to cope with the whole of the water, but it is hoped the colliery proprietors will be able to draw for themselves any water not dealt with by them.

Unemployment.

The unemployment return for the Midlands area has this week taken a decided turn for the worse, the total unemployed being greater by 14,541 than the figure given in the previous weekly return. In a large measure this increase is due to short time working in the colliery areas, added to by an increase of 1387 from the Birmingham industries. The Birmingham total of unemployed now stands at 27,182, and the total for the Midland area 148,581.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The General Outlook.

APART from the heavy electrical branch of the engineering industry, the one with the brightest prospects before it would appear to be that of constructional engineering. From the point of view of actual orders on the books this may not be so. There are, however, a number of exceptionally important inquiries at present being dealt with by local concerns, and there is more than hope that a good proportion of the contracts will be placed in Lancashire. Until quite recently the outlook for constructional engineers was not too good, a number of big jobs being completed or approaching that stage without any prospect of further work coming along to take their place. As indicated, however, the future is regarded much more hopefully. As regards the situation in other branches of engineering, the Manchester Chamber of Commerce, in the course of a review of trade generally, says:—"Electrical engineering firms are fairly busy, and there are more public orders in prospect. Motor manufacturers continue to be well employed, but boilermakers are still having a lean time, and textile machinists, having nearly completed their Russian orders, are more anxious about the future, as the home manufacturing industry is not yet in a position to place much business, although it has much need of replacements, and Far Eastern mill owners' immediate requirements are on a small scale. The machine tool trade continues very dull."

Reduced Profits.

A substantial decline in the profits of the Lancashire Dynamo and Motor Company, Ltd., for last year, attributed to the effects of the coal stoppage, is shown in the annual report of the directors. In 1925 the net profits amounted to £20,201, and in 1924 to £14,320, but last year, after providing for depreciation and debenture interest, the available balance was only £6801. This, with the sum of £2147 brought forward and £15,000 transferred from the surplus of the taxation reserves, makes a total of £23,948. On the ordinary shares a dividend of 5 per cent. less tax is proposed, compared with 7½ per cent. in the previous year, the reserves being increased by £10,000 to a total of £75,000, and the sum of £4127 being carried forward. Mr. F. J. West, owing to pressure of public and business duties, has resigned from the board of directors, and Messrs. J. G. and C. R. Shaw have been elected. Reference is made in the directors' report to the taking over of the Crypto Company by an exchange of shares, with effect from the beginning of the present year.

Non-ferrous Metals.

A somewhat steadier tone has been in evidence on the non-ferrous metal market during the opening days of the present week, after a certain amount of weakness in all sections in the second half of the previous week. In the case of tin the turnover has been a good deal less than usual, and this, in conjunction with the fact that estimates both of stocks in this country and in visible supplies both show increases—the latter from about 14,200 tons at the end of February to over 15,400 tons at the end of last month—naturally had its influence on prices. Steadier conditions, however, have ruled this week, and at the time of writing cash metal at between £310 and £311 per ton and forward at £299 to £300 show an advance compared with the prices last quoted in this column of about £3 in each case. On fairly heavy buying and somewhat steadier advices from the United States copper, after experiencing weak periods, has effected a recovery of a slight portion of the ground lost in the previous week. At the moment the undertone in this section of the market is rather steadier and there has been some indication of improvement in buying interest among industrial users in this country. Both spelter and lead, on balance, are maintained at about the level of values last quoted. Although buying of these metals has been only on a moderate scale, there seems to be at the moment a display of rather increased activity.

Pig Iron.

Under existing conditions on the iron market—both for foundry pig and for manufactured iron—it is difficult to write in a cheerful vein regarding either the present position or immediate prospects. With the foundries paying 3s. per ton less for their particular variety of furnace coke, users of pig iron tend to be rather incredulous when the producers try to impress upon them the fact that they are now paying 2s. per ton more for blast-furnace qualities of coke, and that to look for lower pig iron prices under the circumstances is unreasonable. The fact remains that, so far as any greater freedom of buying is concerned, consumers are obdurate. Towards the end of last week there was a very slight expansion due to the placing of the usual month-end orders, in this case primarily for April delivery, but there is by no stretch of the imagination anything like the usual volume of business that should be placed at this period of the year. How slow the demand is may be judged by the fact that, notwithstanding the higher fuel costs, somewhat lower rates than those last quoted are now being accepted by a number of makers. Derbyshire No. 3, for example, has been shaded for delivery into this area to 89s. to 90s. per ton, with Staffordshire brands at much the same range. Scottish iron is weaker at about 103s. per ton, delivered, and also West and East Coast hematites at 96s. to 97s., although Middlesbrough brands up to the present have shown no change, 92s. 8d. per ton, delivered Manchester or equal, still being asked on this market. The demand for manufactured iron remains very restricted, in spite of the substantial reductions reported here a week ago, and there are probably few Lancashire makers working much more than half-time. Meanwhile, Crown bars are being quoted at £11 per ton and second quality material at £10.

Steel.

In the steel market activity is largely a matter of specifications against existing contracts, and rollers find actual new buying of any consequence a rarity. It is certain that in the majority of instances orders are being completed much more quickly than new orders are finding their way on to the books, and the general position can readily be judged from the tone of the market. Few plate rollers, for example, are unable to furnish quick delivery, particularly of the heavier types, and there is an undoubtedly easier feeling in this section of the market. A number of rollers have, of course, been prepared to accept as low as the official minimum of £8 7s. 6d. per ton for some weeks now, whilst others have been able to maintain their prices at about £8 15s. Many of the latter, however, can now be found who are ready to take £8 12s. 6d., and it may not be very long before all of them are on the minimum basis. In the case of boiler-plates, also, the undertone is easier, and most makers are quoting £11 7s. 6d. So far, sections seem to keep steady at £7 17s. 6d. to £8 2s. 6d., and also basic steel bars at about £9. Continued weakness is to be observed in the market for continental steel, both in finished and semi-finished materials, wire rods being, perhaps, the sole exception. Here again current buying is on a very limited scale. For delivery in this district for cash against shipping documents, Siemens plates are now on offer at about £7 7s. 6d. per ton, with ordinary plates

at £7 2s. 6d. to £7 5s., steel bars at £6 to £6 2s. 6d., sheet bars at £5 12s. 6d., billets at £5 7s. 6d., and wire rods at about £6 7s. 6d. per ton. Galvanised sheets have lost much ground since my last report, and between £14 17s. 6d. and £15 per ton f.o.b. for the usual Indian specifications is now being quoted for the limited business that is passing.

Scrap.

The demand for non-ferrous metal scrap is very moderate, but values are steady, with cast aluminium quoted at about £73 per ton, selected gun-metal at £52, clean light copper at £57 10s., zinc at £25 to £26, lead at £27 to £28, and heavy yellow brass at £45 to £46, for graded materials, delivered to users' works.

Barrow-in-Furness.

Hematite.

As far as production is concerned the hematite pig iron makers are still busy coping with orders for delivery. So heavy are the demands, that practically nothing is going into stock. Such iron as is lying in the works is ear-marked for subsequent delivery. Contracts are gradually being completed, and the number of orders on the books of the various producers are getting less. Orders are being booked in the meantime, but they do not amount to heavy tonnage, and are mostly for immediate delivery. As a matter of fact, the makers are not getting heavy orders with deliveries split up over several months, because there is still the tendency on the part of consumers to wait for a fall in the price which can only happen if fuel becomes cheaper. Fuel is still the important factor in price, and the sooner it comes down the sooner there will be confidence in the iron trade in this district. The native ore mines are experiencing steady trade and local demands are considerable. Of course, the future depends on the iron trade of the neighbourhood, as there is not a large quantity going out of the district. The output of steel continues, but orders are still slow in coming in, which is to be regretted for, if the steel works become quiet, there is certain to be a restriction in the output of iron, as at both Workington and Barrow the steel departments are taking a fair tonnage at present. The outlook in the small section and hoop departments is very good indeed.

SHEFFIELD.

(*From our own Correspondent.*)

Conditions and Prospects.

Although there is little improvement to record in the state of the steel trade at present, a hopeful feeling exists that the turn of the quarter will bring about a more active condition of things. The open-hearth furnaces of the district are still well employed—almost up to capacity—and the accumulations of orders are sufficient to provide them with work for another month or six weeks. The placing of new business, however, is still only on a hand-to-mouth basis. The dearness of pig iron, which is generally held to be the cause of the delay in the real revival of trade, continues. The makers of crucible steel did badly during the last month. There are several grounds, however, for thinking that a better state of things may come about before long, as regards both semi-manufactured steel and finished products. The shipbuilding industry is growing busy, and its activity will call for a great amount of steel in various forms and also of tools. Valuable work will be brought to Sheffield as the result of the important contracts which have been booked lately by electrical engineers. There should also be an increase of orders before long from the railway companies for axles, tires and springs. Bookings for these materials during the past quarter were disappointingly low, but, as the companies are short of rolling stock, it is felt that they cannot indefinitely pursue their policy of holding back work for financial reasons. The quantity of railway orders received from abroad is exceptionally small. A lot of work for India and South America, which formerly came to this country, is now being done on the Continent.

A Works Extension.

It is not often in these days that one hears of a works extension in Sheffield, so that it is a special pleasure to record one when the opportunity occurs. John Bedford and Sons, Ltd., of Lion Works, Mowbray-street, are about to erect rolling mills on a site in Effingham-road. The necessity for this additional plant has been brought about by the development of the firm's new patented "copper core" process of making hollow rolled drill steel, large quantities of which are being exported to the mining fields of South Africa and elsewhere.

Crucible Melting by Electricity.

The old-established method of heating crucible steel furnaces by coke has a serious rival in the form of an electrically heated furnace. The first apparatus of this kind to be used in this country is being installed at the works of Edgar Allen and Co., Ltd., Tinsley, Sheffield, and is expected to be in operation next June. It is known as the Ajax-Northrup furnace. It is quite different from the ordinary electric melting furnace, and will melt small quantities of metal. The metal is heated by induction in a high-frequency field. If the new furnace should prove as successful, mechanically and commercially, as its inventors and makers predict, it is anticipated that its introduction may revolutionise existing methods of producing crucible steel.

Cutlery and Plate.

The cutlery and plate trades are doing better on colonial account. Several of the Empire overseas markets showed a revival in March, especially in the buying of medium and good quality ware, and the month marked a substantial improvement on February. The home trade, on the other hand, continues very flat. Ever since the year opened there has been a great falling off in sales over the counter in all parts of the country, including London. There has also been a considerable decline in the cheap sixpenny bazaar trade.

A Large Road Scheme.

A road reconstruction scheme, which is estimated to cost no less than £100,000, is to be carried out on the important Leeds and Doncaster thoroughfare, between Normanton, Castleford and Pontefract. There have been many complaints as to the condition of this road since the use of the tram track was given up about eighteen months ago. The length to be dealt with is about 6½ miles. The work is to be carried out in a way which is calculated to relieve the authorities of all charges for maintenance for some years, and a good deal of widening is also to be done, in order to secure an almost uniform 30ft. roadway. The owners of the tram track are first to pull up the rails and their containing setts, and the space will be temporarily filled with tar-macadam. The work will then be tackled by the contractors, who, on a 6in. foundation of reinforced concrete, will lay a surface of bitumen. The work will occupy many months. Tenders for the work are now being invited.

Colliery Matters.

Two items of colliery news, of different characters, come from Derbyshire. In the first place, the North Wingfield Colliery, which was closed about two years ago, is to be reopened, as a new seam of excellent quality has been proved. Numbers of workmen are already engaged in "heading out." The colliery formerly employed between 200 and 300 men. The second item relates to the Do-Well Colliery at Barrow Hill, which was sunk by the Staveley Coal and Iron Company a few years ago, but never entirely opened out. Owing to the continued deflation of the coal market, it is now undergoing a process of dismantling. The headstocks and other appliances are being removed for use at other collieries belonging to the same company. The pit is not being permanently shut down, and it can be put into working order again without much difficulty if the state of trade should warrant that step.

Various Schemes.

The Improvement Committee of Rotherham Borough Council has recommended the acceptance of the tender of the Yorkshire Hennibique Contracting Company, amounting to £58,600, for the erection of the new Chantry Bridge. The Rotherham Rural Council is anxious to extend its Dalton-Thrybergh sewerage works, and make them equal to the requirements of a population of 10,000 instead of 5000 as at present. A Ministry of Health inquiry has been held with regard to the Council's desire to borrow £12,563 for the purposes of the work. The Yeadon Waterworks Company has promoted a parliamentary Bill—which has been passed for third reading—under which it seeks to raise further capital and extend its borrowing powers. It also desires to extend the period during which it is to complete the dam of the Riva reservoir, which was sanctioned by the Act of 1916, but has not been carried out for reasons connected with the war. It is now intended to excavate the northern part of the existing dam, so as to extend the area, and also to increase the height of the dam.

NORTH OF ENGLAND.

(*From our own Correspondent.*)

Northern Supremacy.

According to the latest statistics approximately one-third of the national output of pig iron and one-quarter of the steel output is being produced on the North-East Coast. Whether this high production will be maintained, however, is open to question. The majority of the manufacturers certainly have good order books, which assure active employment for a few months to come, but business is not coming forward to replace the contracts which are being rapidly worked off. The fact is that buyers are holding aloof from the market because of the high prices, and it is to be confessed that although ironmasters have little iron to dispose of after meeting their own needs and contract obligations, they are experiencing some difficulty in disposing of the surplus. Cleveland iron is still largely shut out of foreign markets, because it is not down to a competitive price, and even the local market is being invaded by cheap continental iron, which, after paying the North Sea freight, is still cheaper than the local product. Almost the whole of the export trade in pig iron has been lost, and its recovery will only be possible when competitive prices are quoted. The position of Cleveland's pig iron export trade is reflected in the fact that barely 7000 tons were shipped overseas last month, and whilst the total shows an increase on January or February, it is almost negligible. A little more pig iron was shipped to Scotland, and in all the coastwise and foreign shipments of pig iron from the Cleveland district last month totalled 18,588 tons, compared with 14,271 tons in February, and 35,935 tons in March last year. The position in the manufactured iron and steel export trade is much more encouraging. During March 74,891 tons were exported, which is the highest monthly total since March of last year, when 77,258 tons were shipped. In some measure this is due to the fact that arrears of delivery are being overtaken, but the preferential tariff granted by the Indian Government to British steel has also given a welcome stimulus to Cleveland's trade with the Indian Empire, and approximately 20,000 tons were sent there last month. To South Africa and Australia also there were increased shipments, and there is evidence that this healthy overseas demand for steel will be maintained.

More Shipbuilding Orders.

Shipbuilding prospects on the North-East Coast continue to be hopeful, and several new orders are reported this week. R. and W. Hawthorn, Leslie and Co., Hebburn-on-Tyne, have received orders for two naval sloops for the Argentine Government. It is understood that negotiations are proceeding with regard to the construction of warships for the Argentine, and that there is a good prospect of the contract for these vessels being secured by the Tyne. The firms which submitted tenders include Sir W. G. Armstrong, Whitworth and Co., Ltd., Swan, Hunter and Wigham Richardson, Ltd., Hawthorn, Leslie and Co., Ltd., and Palmers Shipbuilding and Iron Company, Ltd. Messrs. Armstrong, Whitworth's have booked an order for an 8900 tons Diesel tank ship for a Rumanian shipping firm. The first shipbuilding orders which William Doxford and Sons, Ltd., of Sunderland, have received for nearly three years have just been placed by Walter Runciman and Co., managers of the Moor Line, Newcastle. They are for two motor ships, fitted with the patented Doxford opposed piston engine. A condition of the contract, however, is that work is not to commence on the ships until September this year.

Cleveland Iron Market.

There is a marked lull in business on the Cleveland pig iron market. Everybody, except the ironmasters, seems to be agreed that prices must fall. The ironmasters, confronted by heavy costs of production, are most reluctant to make further reductions, and as practically the whole of their output is going into immediate consumption, they have not the embarrassment of heavy stocks to weaken their attitude. The continued abstention of buyers, however, can have only one end. Makers have only the home market to depend upon. Foreign business is impossible. European pig iron is being imported into the Tees at 72s. 6d. per ton c.i.f., whereas Cleveland No. 3 foundry iron is at 80s. per ton. Makers, however, still adhere to recent prices, No. 1 being 82s. 6d., No. 3 G.M.B. 80s., No. 4 foundry 79s., and No. 4 forge 78s. 6d.

Hematite Pig Iron.

Increased production and the keen anxiety of makers of hematite to secure sufficient orders to ensure continuity of operations has had the effect of further depressing the price of East Coast mixed numbers to 84s. per ton, and even that figure could be shaded for a substantial order. A little iron is being shipped to Italy, but, generally speaking, the price is too high for foreign buyers, though it is relatively cheaper than foundry iron.

Ironmaking Materials.

Some big contracts have recently been arranged in the foreign ore trade, and sellers are now so comfortably situated that they are not pressing sales, and, in fact, declare that there is likely to be a shortage. Best Rubio ore is firm at 22s. per ton c.i.f. Tees. Sellers of Durham blast-furnace coke quote all kinds of prices, but it is obtainable at a delivered price of 24s. per ton, and buyers are still insistent that the price is too high.

Manufactured Iron and Steel.

The manufactured iron and steel trade presents no new feature of moment. There is a modest flow of new business, but in volume it falls considerably short of the output. Exports continue on a heavy scale, and on the whole the steel trade is distinctly more active than is the pig iron trade. Prices are all firm and unchanged.

Iron and Steel Imports.

Imports of iron and steel into the Tees-side district still continue on a heavy scale. Statistics presented at this week's meeting of the Tees Conservancy Commission showed that the imports from European countries, India and coastwise for the five months ending March 31st, totalled 179,303 tons, as compared with 94,999 tons in the corresponding period of 1925–26, and 31,266 tons in 1913–14. Crude sheet bars, billets, blooms, slabs, &c. imported reached 87,682 tons for the five months, as against 58,855 tons in 1925–26 and 19,970 in 1913–14. The success which is attending European competitors in the pig iron trade is reflected in the fact that no less than 66,303 tons of pig iron were brought into the port, or more than double the quantity received during the same period of 1925–26. In the same five months of 1913–14 only 34 tons were imported. There was also a marked increase in the imports of plates, bars, angles, rails, sheets, joists, &c., the total for the five months being returned at 25,518 tons, as against 6144 tons in 1925–26 and 11,242 tons in 1913–14.

The Coal Trade.

There is no special sign of any revival of interest in the Northern coal trade. The general outlook remains very disappointing for export up to Easter, and for later the position is nominal. Inquiries, if anything, are more numerous, but continental buyers' ideas are still much below local prices, mainly owing to the severe competition of German, Polish and Westphalian coal. At all centres foreign producers are now offering supplies at similar prices to British coal, despite high railway charges. The prospects are not bright for coal fitters. A few are well booked, but the great majority are badly in need of additional trade. The special classes of steams are moderately well booked, and sellers can afford to hold steadily, but all other grades are having difficulty in clearing production. Northumberland steams are quoted at 15s. 6d. and secondary qualities at 15s. The best Wear steams are firm at 19s. 6d. to 20s., owing to the limited supplies available. Smalls are scarce at 10s. 6d. to 11s., while ordinary qualities command 10s. There is not much pressure in the gas coal trade. Best Durham gas coals are unchanged at 17s. to 17s. 6d., and secondaries and good coking unscreened are freely obtainable at 15s. to 15s. 6d. Durham bunker coals are quiet; ordinary at 15s., and best and specials 16s. 5d. to 16s. 6d. With the production increasing and the demands very slow, prices for household coal are steadily weakening, and prices, as compared with values ruling through March, are 2s. to 3s. per ton less for April deliveries. The coke market is fairly steady. Consumptive demand is active, but production is ample to meet all orders. Gas coke holds steadily for export to 22s. 6d. to 23s. Patent cokes are plentiful at 24s. to 26s., and best foundry cokes are 30s. to 32s. 6d.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

STATISTICS for the month of March denote a steadily improving output from Clyde shipyards, and there appears little doubt that, given an adequate supply of material, the rate of production will soon be accelerated. Last month's total was low compared with past averages, but the shipbuilding trade is still in the recovery stage, as also are those trades supplying the necessary materials, and prospects are now considerably brighter. Delayed deliveries of steel plates and sections greatly hamper the work at the shipyards, and it may be some time yet before steel works can overtake arrears of contracts. During the month of March eleven vessels of 30,915 tons aggregate were launched from Clyde yards, and the largest of them was the light cruiser Australia, 10,000 tons, and 90,000 horse-power, built at Clydebank for the Commonwealth of Australia. Included in the returns were three cargo steamers of between 5000 tons and 6000 tons each, and a number of smaller craft. Among the latter was the steamer Lipis, 845 tons, for the Straits Steamship Company, Ltd., Singapore. A number of fresh contracts have been reported during March, and prospects are considerably brighter. New orders include three P. and O. steamers of 10,000 tons each; a motor vessel of 10,000 tons, and one of 9000 tons; a Diesel electric oil tanker of 9200 tons; an oil tank steamer of 8600 tons; and two cargo steamers of 8000 tons each.

Steel.

The feature of the steel trade is the continued shortage of fresh business. Makers, however, are hopeful of an early improvement in this respect. Plate and section mills are fully employed, and have sufficient work on hand to provide occupation for some months yet. Consumers deplore protracted deliveries, and the situation would be worse were it not that in some cases continental steel is being utilised.

Steel Sheets.

As is usual at this season of the year the market for sheets is quieter. The lighter gauges are busier than the heavy varieties, and it is said that export merchants have bought fair quantities of the cheaper qualities of black and galvanised at reduced prices. Some producers are well sold, but others are in need of orders for both black and galvanised.

Bar Iron.

Bar iron makers have now overtaken most of the accumulated orders and works are slackening off. Business has not yet shown benefit from the reduction of 10s. per ton in price, and the quieter conditions are also apparent in the re-rolling departments.

Pig Iron.

The number of pig iron furnaces in blast has been increased to thirty-four. The demand for hematite increases and the supply is by no means plentiful, but foundry qualities are in plentiful supply, and tend easier in price. Continental pig iron for the manufacture of steel by the basic process is being used in considerable quantities locally.

Coal.

The coal market, on the whole, shows little sign of returning strength. Some fuels, notably certain washed materials, are steadier in price owing to decreased supplies, but demands from all quarters are far below normal. Collieries in the East of Scotland feel most keenly the lack of export business, and in this respect the inquiries from the Baltic are most disappointing. Exporters are not confident of an early improvement in view of keen competition from home as well as foreign fuel. Short time is the general rule in all areas, and in very few cases are deliveries booked more than two or three days ahead. Aggregate shipments amounted to 252,434 tons, against 236,269 tons in the preceding week, and 238,768 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THERE has not been much, if any, alteration in the conditions in the steam coal trade during the past week. Most of the collieries are fairly comfortably off for prompt orders, except in the case of dry coals, and it is scarcely likely that much change will be seen until after Easter, as all the leading undertakings have very little coal to sell and the loss of practically a week's output at Easter will make a very appreciable difference to the position. There is a good deal of tonnage due to come along, most of which will probaby be got away before the holidays. The outlook for new business is at the moment not quite so good. Possibly operations are being held in check by reason of the fact that many leading coals are unobtainable for early loading. At the same time, there is evidence that foreign buyers are not pressing for fresh supplies, and as a matter of fact, are rather discounting present values. The first excitement caused by the reports of strike troubles abroad has somewhat worn off, and it is fairly clear that this market is not going to benefit anything like immediately. So far as can be seen there is to be no interruption in work at the coalfields in France, and in the case of America all reports go to show that it must be some time before the real necessity occurs for supplies to be drawn from South Wales. It is understood that the men in the bituminous section of the American coalfield who are on strike represent about 35 per cent. of the total employed, and, further, that the Americans have stocks running to approximately 80 million tons. In these circumstances, it may be several months before the strike in that country has any beneficial effect upon the coal trade here.

Coalfield Items.

The conditions prevailing in the coalfield do not appear to be any too settled in several of the districts, and no doubt some of the extremists will make the most of the situation to create trouble. In the Rhondda there are, according to one miners' leader, 12,000 to 14,000 miners unemployed, and for approximately 10,000 of them there is no hope of their being re-absorbed into the industry. The position may become even worse, as it is understood to be well within the bounds of possibility that two or three of the older collieries in the district may close down in the next few years. The question of non-unionism is another matter that may cause a good deal of disturbance, as the feeling between the rival unions is by no means satisfactory. It is reported that the Coalowners' Association has decided to recognise officially the new Industrial Union, which now has branches in most parts of the coalfield, and, as a consequence, it is the intention of the Union to move its offices from Bargoed to Cardiff. The Blaenavon Company's collieries became idle on Tuesday of last week on account of the action of the supporters of the Miners' Federation taking steps to compel a few men to join their organisation, although the men in question were members of another union. By the end of last week they had fallen into line, and were all ready to resume work, but the colliery management decided not to reopen the pits until it had had an opportunity of discussing the matter with the board of directors, which was to meet in London this week.

Easter Holidays.

It was recently decided that the holidays in the coalfield should be three days at Easter. Since then representatives of the employers and the coal tippers and trimmers have met to discuss the matter, as it affects work at the docks in South Wales. The decision come to is that on Thursday, the 14th inst., there will be continuous working from 7 a.m. to 10 p.m. in two shifts, one shift being from 7 a.m. to 3 p.m. and the second from 3 p.m. to 10 p.m. In the case of Port Talbot, work will commence at 8 a.m. Meal hours are to be the subject of local arrangement. Good Friday, of course, will be a holiday. On Saturday, the 16th inst., work will commence at 7 a.m. and continue to noon, but in the case of steamers which can be finished, work will run on to 1 p.m. Easter Monday and Tuesday will be holidays.

Ship-repairing Industry.

It is understood that the negotiations which have been proceeding for months past regarding a revision of the working conditions in the dry dock and engineering industry of South Wales, have reached a stage at which agreement as to principles has been arrived at and a joint sub-committee is to proceed to draft suitable wording for the agreement necessary before the whole question can be submitted for the approval of the constituent bodies. It is expected that the work of compilation and the necessary reference to the constituent authorities will enable the revised conditions to be brought into operation from July 1st next.

Steel and Tin-plate News.

The announcement was made that Baldwins, Ltd., would close on Saturday last the six furnaces at the Landore Steel Works for an indefinite period, owing to the lack of orders, but at the end of last week it was decided to close only four of the furnaces. The other two will remain in commission. Altogether 400 men are employed at the works. Hopes are entertained that sufficient work will be found to maintain work at the two furnaces for some time, and so reduce the amount of unemployment in the district. There was trouble last week at the Wern Tin-plate Works, Briton Ferry, belonging to Baldwins, Ltd., owing to a strike on the part of the men, consequent upon the dismissal of a roller man. On Saturday last, the workmen, who are members of the Iron and Steel Trades Confederation, decided to take the advice of their leaders and to return to work, on the understanding that the question of the man's dismissal would be considered jointly by the management and the men's leaders.

New Pumping Scheme.

The Newport Electricity Committee decided on Thursday of last week to recommend the Council to proceed with a pumping scheme at the power station at East Usk, which, it is estimated, will cost £70,000.

Cardiff Shipowners.

According to the annual return issued by the secretary of the Cardiff district branch of the Shipping Federation for last year, the number of shipowning firms was eighty-two, as against ninety-three in 1925, but the gross tonnage owned amounted to 1,164,907, compared with 1,135,049 in 1925, 1,002,000 in 1924, and 1,003,000 in 1923. Sir William R. Smith and Sons, Ltd., head the list as the largest local ship managers, as they have under their control twenty-nine vessels of 145,303 gross tons.

Current Business.

The tone of the market is well maintained. As a matter of fact, the conditions present little or no feature, as there is not a great deal of new business passing. Most of the collieries are very full up, and have no coals to spare for early shipment. Dry coals and some of the inferior qualities continue to be rather an exception to this statement. Smalls are also steady, while coke is firm, there being a good inland demand for this commodity. Pitwood is quietly firm at 40s. for prompt delivery.

LAUNCHES AND TRIAL TRIPS.

CITY OF HEREFORD, single screw steamer; built by Barclay, Curle and Co., Ltd.; to the order of the Ellerman Lines, Ltd.; dimensions, 398ft. 6in. by 51ft. 6in. by 32ft. 8in., 5100 gross tonnage. Engines, triple-expansion, 24in., 41½in., 72½in. by 48in. stroke; constructed by the builders; launch, March 22nd.

TELA, passenger and fruit-carrying steamer; built by Workman, Clark and Co., Ltd., to the order of the United Fruit Company of Boston; dimensions, 355ft. by 48ft. by 31ft. 6in., 4200 gross tonnage. Engines, direct-acting, inverted four-cylinder triple-expansion, surface condensing; constructed by the builders; launch, March 24th.

ELAX, motor tanker; built by the Netherlands Shipbuilding Company; dimensions, 440ft. by 59ft. by 32ft. 9in.; 10,000 tons deadweight. Engines, double-acting four-cycle; constructed by Werkspoor, Amsterdam; launch, March 26th.

HEDGEHOPE, steel screw steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Medomsley Steam Shipping Company, Ltd.; 8000 tons deadweight. Engines, triple expansion; constructed by the builders; trial trip, March 29th.

PAHUD, steamer; built by The "De Maas" Shipbuilding Company, to the order of the Royal Packet Company, of Amsterdam; dimensions, 299ft. 10½in. by 45ft. 11in. by 17ft.; 1340 tons deadweight. Engines, 1700 I.H.P.; constructed by Fyenoord, Rotterdam; launch, March 29th.

SIN KHENG SENG, single-screw steamer; built by Harland and Wolff, Ltd., to the order of Mackie and Baxter, Ltd., for the Strait Settlements Coasting Trade; dimensions, 110ft. by 22ft. by 9ft. 6in.; 200 gross tonnage. Engines, triple-expansion, surface condensing; constructed by Mackie and Baxter, Ltd.; delivered April 1st.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has been successful in obtaining a twelve months' contract from the London and North-Eastern Railway for the supply of Mazda electric lamps.

PERRY AND CO. (Bow), Ltd., of Westminster, have received from the Service Petroleum Company, Ltd., an order to erect 100 new petrol filling and service stations in various parts of the country, including London, Manchester, Birmingham, Newcastle, Bristol, Cardiff, Coventry, Leeds, and Sheffield.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has received from the Japanese Broadcasting Association an order for three broadcasting transmitters for Japan, designed to give 10 kilowatts of aerial energy. One is for Tokio, another for Osaka, but the situation of the third station has not yet been indicated.

STANDARD TELEPHONES AND CABLES, Ltd., of Bush House, Aldwych, London, W.C. 2, have received an order for the complete wireless equipment for three broadcasting stations, their associated studios and necessary machinery, from the Japanese Broadcasting Association. The equipments are to afford a power of 15 kilowatts according to the Geneva system of rating.

GUEST AND THORNE, CHAPMAN, Ltd., of 81, Gracechurch-street, London, E.C. 3, inform us that the Corporation of Port Elizabeth, Cape Province, has recently given an order for cast iron pipes, the value of which is £76,991, to their South African house, Guest, Sykes and Chapman, Ltd., whose head office is at Johannesburg. The pipes are being manufactured by Cochrane and Co., Ltd., of Middlesbrough.

THE CHARLES R. E. BELL FUND SCHOLARSHIPS.—The successful candidate for the "Charles R. E. Bell Fund" Junior Scholarship of £60 offered by the London Chamber of Commerce on the results of the Winter (February) examination was George F. Quaintance, presented from the Tollington Park L.C.C. Central School, Marriott-road, London, N. 4. The London Chamber of Commerce offers another "Charles R. E. Bell Fund" Scholarship of £60 on the results of the Summer (July) examination, and two "Charles R. E. Bell Fund" senior travelling scholarships of £150 each on the results of the spring examinations, 1927.

THE METROVICK CARNIVAL.—On Friday, April 1st, the employees of the Metropolitan Vickers Electrical Company, Ltd., held their fourth annual carnival at the Free Trade Hall, Manchester. Nearly 3000 people were present, and all departments of the company were represented. The board of directors was represented by Captain Hilton, vice-chairman, Colonel Craddock, Mr. Alex. Spencer, Mr. McKinstry, and Mr. G. E. Bailey. In their disguises the heads of departments were in some instances unrecognised by their subordinates. The lighting decoration and mechanical effects were devised and carried out by the company's staff, nearly 40 kilowatts being required for lighting and power. For the benefit of friends unable to attend, the music was broadcast between 11 and 11.30 p.m. Great credit is due to the organisers of the show, and especially to the engineers who, among other things, designed two giant figures known as "Reggie" and "Rastus," that stood on either side of the orchestra platform and waved their limbs and rolled their eyes. Altogether 3000 balloons were used for the decorations, and when they were released during the carnival dance few, if any, survived the mad rush of the crowd for them. In addition to the dancing cabaret turns were given by the girl workers who had been specially trained. Although this is the fourth carnival the company has held, it did not lack originality, and the organisers are to be congratulated upon the general excellence of the show.

THE INSTITUTION OF ENGINEERS-IN-CHARGE.—The twenty-seventh annual dinner of the Institution of Engineers-in-Charge was held at the Holborn Restaurant on Saturday, April 2nd, with Mr. Loughnan Pendred, President, in the chair. The attendance was very good, and many eminent engineers were present as guests. In an admirable speech Sir Philip Dawson proposed the toast of the Institution. In acknowledging it the President remarked upon the great economy with which the Institution was run, and congratulated it upon the fact that the membership was nearly five hundred. He touched also upon the Benevolent Fund, and asked members to bear it in mind. Mr. Henry King, vice-chairman of the Institution, proposed, in eloquent terms, the toast of the Guests, and both Sir Henry Fowler and Dr. Ormandy, who acknowledged it, gave cheery and amusing speeches. The last toast was that of the President, which was most amusingly proposed by Mr. W. Edwards, chairman of the Institution, who quoted the President's Horoscope as cast by Captain Penn. In acknowledging it, Mr. Pendred spoke with confidence of the future of the engineering industry in Great Britain, and laid particular stress upon the need of human sympathy and human understanding in all branches of that industry. A toast not on the list was that of the hon. secretary, Captain Penn, which was proposed by Mr. Patchell, Past-President, and, needless to say, was received with the greatest heartiness. An excellent musical programme helped to make the evening pass very happily.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 5 0 to 4 7 6	
No. 1 Foundry	4 11 6	—
No. 3 Foundry	4 6 6	—
N.E. Coast—		
Hematite Mixed Nos.	4 4 0	4 4 0
No. 1	4 4 6	4 4 6
Cleveland—		
No. 1	4 2 6	4 2 6
Silicious Iron	4 2 6	4 2 6
No. 3 G.M.B.	4 0 0	4 0 0
No. 4 Foundry	3 19 0	3 19 0
No. 4 Forge	3 18 6	3 18 6
Mottled	3 17 6	3 17 6
White	3 17 6	3 17 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	4 0 0	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
Foundry Forge	3 10 6	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 15 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 1 6	—
No. 4 Forge	—	—
Basic	4 0 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 17 6 (a); 5 0 6 (b); 5 — 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best	—	—
N.E. Coast—		
Iron Rivets	12 15 0	—
Common Bars	11 15 0	—
Best Bars	12 5 0	—
Lancs.—		
Crown Bars	11 0 0	—
Second Quality Bars	10 0 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	11 15 0	—
Best Bars	12 5 0	—
Hoops	14 0 0	—
Midlands—		
Crown Bars	11 7 6	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 7 6	—
Gas Tube Strip	12 15 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	11 0 0
Ship Plates, ¾in. and up	8 7 6	£8 0 0 to 8 5 0
Sections	7 17 6	£7 10 0 to 7 15 0
Steel Sheets, under 3/16 in. to ¼in.	10 0 0 to 12 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	£15 0 0 to 16 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 10 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0†	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	9 0 0	—
,, (Small Round)	8 10 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 12 6	—
,, (Lancs. Boiler)	11 7 6	—
Sheffield—		
Siemens Acid Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 5 0	—
Midlands—		
Small Rolled Bars	8 15 0 to 9 0 0	
Billets and Sheet Bars	7 0 0 to 7 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	15 5 0 to 15 7 6	
Angles	7 15 0 to 8 0 0	
Joists	7 15 0 to 8 0 0	
Tees	8 15 0 to 9 0 0	
Bridge and Tank Plates	8 12 6 to 9 0 0	
Boiler Plates	11 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/7½ to 20/-
Block Tin (cash)	310 15 0
,, (three months)	299 15 0
Copper (cash)	55 5 0
,, (three months)	55 15 0
Spanish Lead (cash)	26 15 0
,, (three months)	27 8 9
Spelter (cash)	29 13 9
,, (three months)	30 5 0
Manchester—	
Copper, Best Selected Ingots	61 10 0
,, Electrolytic	62 7 6
,, Strong Sheets	86 0 0
,, Tubes (Basis Price) lb.	0 1 0½
Brass Tubes (Basis Price) lb.	0 0 11½
,, Condenser lb.	0 1 1½
Lead, English	28 7 6
,, Foreign	27 12 6
Spelter	30 5 0
Aluminium (per ton)	£107

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/5½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
,, ,, 6 p.c. to 8 p.c. ,,	£22 10 0	7/3
,, ,, 8 p.c. to 10 p.c. ,,	£22 7 6	6/6
,, ,, Specially Refined		
,, ,,Max. 2 p.c. carbon	£36 2 6	11/6
,, ,, ,, 1 p.c. ,,	£42 5 0	15/-
,, ,, ,, 0.70 p.c. carbon	£54 0 0	17/6
,, ,, ,, carbon free	1/5d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 17 6 scale 5/- per unit	
,, ,, 75 p.c.	£19 0 0 scale 6/- per unit	
,, Vanadium	14/3 per lb.	
,, Molybdenum	5/- per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(Prices not stable.)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/6
,, ,, Ell	15/3
,, ,, Splint	15/9 to 17/-
,, ,, Trebles	14/6
,, ,, Doubles	13/9
,, ,, Singles	13/6
Ayrshire—	
(f.o.b. Ports)—Steam	15/-
,, ,, Jewel	17/-
,, ,, Trebles	15/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/9 to 15/-
Screened Navigation	22/-
Trebles	13/9
Doubles	13/9
Singles	13/6
Lothians—	
(f.o.b. Leith)—Best Steam	13/9
Secondary Steam	13/-
Trebles	14/-
Doubles	13/6
Singles	13/3

ENGLAND.

	Inland.	Export.
(8) N.W. Coast—		
Steams		27/6
Household		42/6 to 58/6
Coke		30/6
Northumberland—		
Best Steams		15/6
Second Steams		14/6 to 15/-
Steam Smalls		10/6
Unscreened		15/6
Household		21/- to 27/-
Durham—		
Best Gas		17/- to 17/6
Second		15/6 to 16/-
Household		21/- to 27/-
Foundry Coke		26/6 to 27/6
Sheffield—		
Best Hand-picked Branch	34/-	
Best Selected House Coal	27/- to 29/-	—
Screened House Coal	23/- to 25/-	—
,, ,, Nuts	19/- to 21/-	—
Yorkshire Hards	18/- to 20/-	—
Derbyshire Hards	18/- to 20/-	—
Rough Slacks	11/- to 12/-	—
Nutty Slacks	8/- to 9/-	—
Smalls	3/- to 5/6	—
Blast-furnace Coke (Inland)	22/- to 27/6 at ovens.*	
,, ,, (Export)	f.o.b.	28/- to 30/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	23/- to 24/-
Second ,, ,,	22/6 to 23/-
Best Dry Large	21/- to 22/-
Ordinary Dry Large	20/- to 21/-
Best Black Vein Large	21/9 to 22/3
Western Valley Large	21/6 to 21/9
Best Eastern Valley Large	20/6 to 21/-
Ordinary ,, ,,	20/- to 20/6
Best Steam Smalls	14/6 to 15/6
Ordinary Smalls	13/- to 14/-
Washed Nuts	18/- to 22/-
No. 3 Rhondda Large	25/- to 26/-
,, ,, Smalls	16/6 to 17/-
No. 2 ,, Large	21/- to 22/-
,, ,, Through	18/- to 19/-
,, ,, Smalls	13/- to 14/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	30/- to 32/6
Patent Fuel	26/- to 27/-
Pitwood (ex ship)	40/- to 40/6
Swansea—	
Anthracite Coals :	
Best Big Vein Large	37/6 to 42/6
Seconds	32/6 to 35/-
Red Vein	27/- to 29/6
Machine-made Cobbles	42/6 to 47/6
Nuts	45/- to 50/-
Beans	42/6 to 45/-
Peas	22/6 to 24/6
Breaker Duff	8/6 to 9/3
Rubbly Culm	12/- to 12/9
Steam Coals :	
Large	22/- to 22/6
Seconds	20/6 to 21/6
Smalls	12/6 to 13/6
Cargo Through	17/- to 18/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. † Latest quotations available.

(a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. * Open market price. Special price for pig iron producers, 22/- per ton at ovens.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Outlook.

THE situation of the engineering trades remains unchanged, and work continues extremely scarce, with very little hope of an early improvement. The reduction in the price of coal and coke are regarded as a favourable indication, but they have not yet affected iron and steel, quotations for which are well maintained. Prices of rails on the international market have been advanced 5s. a ton. The negotiations for centralising the sales of rolled steel have fallen through, temporarily, on account of the claims of French and Belgian mill and forge owners for higher quotas, which the Germans refused, but another meeting is to be held next month, when an attempt will be made to come to an agreement on another basis.

Railway Electrification.

The Paris suburban State Railways are being electrified in three zones, each having its own train service. The trains for the third zone, for example, pass through the first two zones without stopping. The first zone between the Gare St. Lazare and Bois-Colombes and Meudon has been in service for some time. The second zone is complete, except for the section between Colombes and Argenteuil, which, however, is not likely to be put in hand yet awhile, and the third section was put into operation recently by the opening of the electrified line to Saint-Germain. This line is particularly difficult for steam locomotives on account of the exceptionally steep gradient through the Le Pecq Tunnel. The electric trains have reduced the time between the Gare St. Lazare and Saint-Germain from more than an hour to 25 minutes. During the present year the line to Versailles will be completed, and when the section between St. Cloud and Saint-Nom-la-Bretèche is electrified, the whole suburban system will be practically terminated. At a later date the line between the Gare Montparnasse and Orsay will be electrified. The current for working the suburban railways is supplied by two power stations, one at Bezons and the other at Moulineaux.

Paris Water Supply.

The opposition of the Chambers of Commerce in towns on the Loire to the carrying out of the proposed scheme to bring subterranean water from the Vals de Loire to Paris has in no way abated the determination of the Paris municipal engineers to carry the scheme through. It offers the only means of guaranteeing adequate supplies in the future when Paris will have extended to far beyond its present limits. The rate of increase in population raises a serious problem as to how Greater Paris will be supplied with water ten years hence. As a means of removing all obstacles to the carrying out of the proposal the Prefect of the Seine has sent a memorandum to the Paris Municipal Council suggesting that the Government should be asked to introduce a Bill declaring the scheme for bringing water from the Vals de Loire a work of "public utility." At the same time the financial side of the undertaking is to be closely examined, particularly with respect to obtaining German aid on account of reparations. The scheme is, indeed, now entering upon an active phase when commissions will be appointed to investigate all the different aspects of the question. The Vals de Loire scheme will be one of the largest of the kind yet undertaken, and it can obviously only be acceptable if definite proof be forthcoming that the pumping of water to meet the requirements of Paris will not lower the subterranean water to the detriment of local users and of the level of the Loire.

Water Sterilisation.

Along the Riviera the water is almost generally sterilised by the ozone process, following upon experiments carried out nearly twenty years ago at Nice, when the system was tried in the hope of suppressing the periodical epidemics of typhoid fever. The water at Nice is obtained from the sources of the Sainte-Thècle, the Paillon torrent and the river Vesubie. The hydraulic power available was utilised to produce the electric current required for the ozone process, and the results were so satisfactory that in 1912 all the towns on the Riviera combined to lay down similar plants for the treatment of their water supply. Recently the Municipal Council of Nice doubled the capacity of the existing plant at Saint Pierre de Feric.

Motor Car Industry.

When the export trade in motor cars suddenly ceased through the increased values following upon the appreciation of the franc the situation of makers became so precarious that their only hope of salvation appeared to lie in an amalgamation of interests, whereby it would be possible to simplify the administrative services and effect considerable economies all round. A first attempt to create a group in which two of the oldest firms would be included failed because it was found to be too late to save De Dion-Bouton from liquidation. Another group composed of Delahaye, Unic and Chenard-Walcker, has now been formed. Each will continue its own manufactures covering particular types of cars, but all three companies will be under one Board of management and all purchases in raw material will be made in common. It is obvious that this practice must be extended if the industry is to pass successfully through a very difficult period.

British Trade.

While France is making special efforts to reduce the importation of British coal and other products, it appears to overlook the fact that Great Britain is by far the most important customer for French goods. During the first two months of the year the value of French goods exported to Great Britain was 1736 million francs, an increase on the corresponding period of last year of 246 million francs. The imports from Great Britain into France during the same period amounted to 954 million francs, a decline of no less than 25 per cent.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

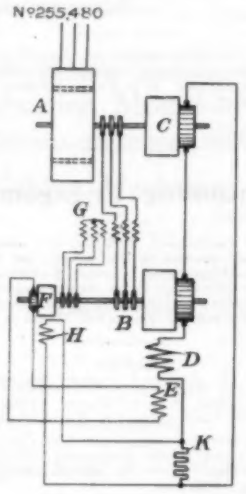
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

255,480. July 16th, 1926.—IMPROVEMENTS IN OR RELATING TO THE REGULATION OF ASYNCHRONOUS ELECTRIC MACHINES, Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

An example of the application of the invention to the well-known Kramer cascade arrangement is illustrated in the accompanying drawing. A is the asynchronous machine to be regulated, which sends its slip current into the sliding or collector rings B of the rotary converter which supplies direct current from its commutator to the direct-current machine C coupled to the asynchronous machine. In addition to the usual interpole winding D there is a second winding E which is supplied with current from an auxiliary machine F also coupled to the rotary converter. The auxiliary machine is excited by the alternating current as well as by the continuous current of the rotary con-

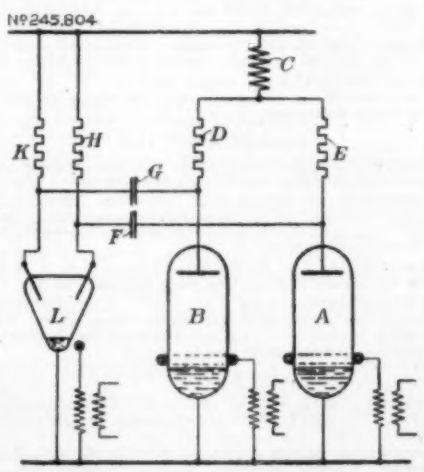


verter. The exciting alternating current is supplied to the rotor of this machine through the series transformer G, whilst the direct current is supplied to the magnet winding H in the form of branch current from the resistance K in the main circuit. The two excitations of the auxiliary machine F are adjusted in such a manner that in the normal state they balance each other, whilst in the event of fluctuations in the ratio of the three-phase current producing them, to the continuous current, they give a differential excitation which generates in the machine F an exciting current which flows through the winding E and strengthens or weakens the interpole field of the rotary converter. In that way the injurious effect of the retardation and acceleration currents in the armature of the converter is compensated, and the commutation of the converter is no longer disturbed by these currents.—*February 24th*, 1927.

SWITCHGEAR.

245,804. January 11th, 1926.—A DEVICE FOR EXTINGUISHING DISCHARGE TUBES FUNCTIONING AS SWITCHES, Siemens and Halske Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

A method of extinguishing parallel-connected vapour discharge tubes operating as switches is described in this specification. A and B are the vapour discharge or switch tubes which are intended to switch in the resistance C. Resistances or choking

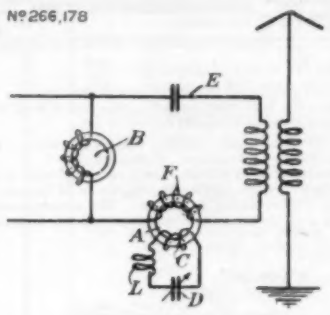


coils D and E are provided for the purpose of equalising or balancing the vapour discharge tubes. Between the latter and the vapour discharge tubes are capacities F and G, which are charged through the resistances H and K. The capacities F and G can be connected to the cathodes of the switch tubes A and B by means of the auxiliary vapour discharge tube L. This connection ensures an absolutely reliable extinction of the tubes A and B.—*February 24th*, 1927.

TELEGRAPHS AND TELEPHONES.

266,178. May 14th, 1926.—ELIMINATION OF DISTURBING OSCILLATIONS IN RADIO SIGNALLING SYSTEMS, *Leonard Mellersh Jackson, of Haseltine, Lake and Co.*, 28, *Southampton-buildings, Chancery-lane, London, W.C. 2.*

The object of this invention is to eliminate in transmitting or receiving circuits higher harmonics, side frequencies, or other disturbing waves. A filter transformer A with an iron core is connected as shown, and it is provided with two windings, the secondary winding C being tuned by a variable condenser D in series with an inductance L. This circuit is tuned to resonance with the operative waves. In the circuit E B F there is a series of higher harmonics and side frequencies in addition to the

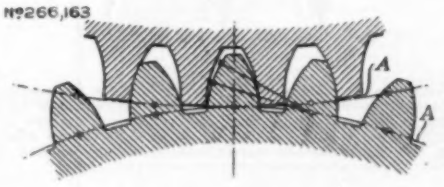


desired waves, and these meet in the primary F of the filter transformer, which has such a high resistance loss that they become extinguished. For the operative wave, however, the primary winding acts as a low-resistance path, owing to the high resonant current produced in the secondary circuit C L D. The field of the operative waves in the iron core of the filter transformer A is annulled, and in that way the self-induction and the iron losses are practically cancelled. By making the self-induction L large with respect to the capacity D the damping of the secondary circuit may also be held at a low value so that very close side frequencies will be suppressed and the filtering action of the transformer improved.—*February 24th*, 1927.

TRANSMISSION OF POWER.

266,163. April 7th, 1926.—TOOTHED GEARING, E. Wildhaber, 379, Alexander-street, Rochester, New York.

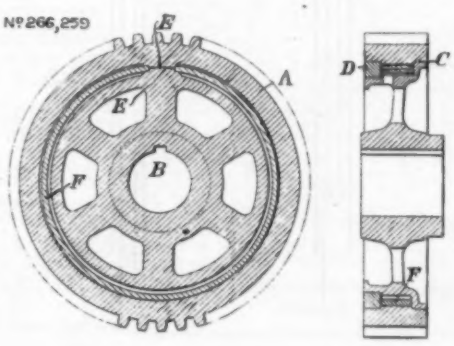
This form of gear tooth, which is put forward as being specially applicable to helical gears, is said to have a long wearing life and to be quiet when running at high speeds. As shown in the drawing,



the profiles of the teeth are arcs of circles struck from centres on the pitch circles A A. The radius is preferably one to one and a-half times the pitch. It is said that engagement between the teeth occurs only through a very small angle of rotation—instantaneously according to theory—and then passes to the next pair of teeth.—*February 24th*, 1927.

266,259. November 6th, 1926.—FLEXIBLE GEAR WHEELS, *The Metropolitan-Vickers Electrical Company, Ltd.*, 4, *Central Buildings, Westminster.*

The gear ring A is mounted on its centre B, but is free to rotate about the face C and the retaining ring D. The torque is transmitted from the ring to the centre through the two lugs E E and the hoop spring F. The force is transmitted from one lug to the other throughout the length of the spring and results in the spring unwinding against the inside of the gear ring. This un-



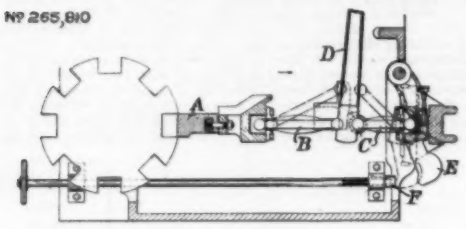
winding action of the spring results in shortening the effective spring length as the portion conforming to the inner periphery of the gear rim can deflect no further. The result of this shortening action is to give the spring a rising characteristic; that is, a resistance to deflection that increases with the deflection. This characteristic is very effective in damping vibrations, and as the deflection becomes relatively small in proportion to the load at high torques, no positive connections or stops are required.—*February 24th*, 1927.

MACHINE TOOLS AND SHOP APPLIANCES.

265,810. April 6th, 1926.—BRICK-MAKING MACHINES, Thos. C. Fawcett, Ltd., Hunslet, Leeds; D. L. Fawcett and A. E. Bottomley.

This device is intended for adjusting the stroke of the press plunger A of a brick-making machine and, consequently, the amount of clay accepted at each stroke. The plunger is actuated by the toggles B and C, which are operated by the vertical movement of the link D. On the forward stroke, which is shown completed, the reaction is taken by the toggle C bearing against the

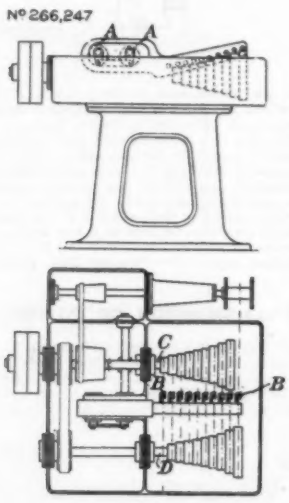
end frame. On the return stroke both toggles are, more or less, free to retract, but the freedom of C is restrained by the rocking lever E meeting the stop F. When the lever meets this stop all



the backward movement is concentrated in the ram A. It follows that if the lever E is held tight the ram has a long stroke and *vice versâ*.—*February 17th*, 1927.

266,247. October 11th, 1926.—WIRE DRAWING MACHINES, W. Gerhardi, Lüdenscheid, Germany.

The inventor aims at the automatic clearing away of the refuse which tends to accumulate on the inlet side of the die blocks of continuous wire-drawing machines. He consequently moves the dies in a circle transversely to the general direction of the

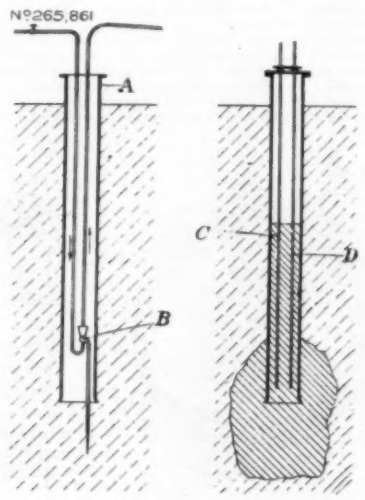


wire, so that the wire really approaches the die in a conical path and wipes away the detritus. This circular movement of the die plate is produced by the two interconnected excentrics A A. Guide rollers B B ensure that the wire leaves the die axially. The first drawing spindle C is set lower than the second D to the extent of the excentric radius.—*February 24th*, 1927.

BUILDING.

265,861. August 4th, 1926.—CONCRETE PILES, A. Wolfsholz, 16, Via Montebello, Milan, Italy.

The inventor first drives a tubular pile A and then excavates a chamber round its lower end by means of an ejector B. This

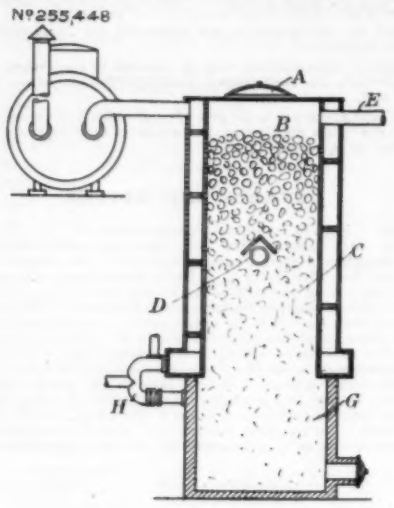


cavity is then filled with concrete through the pipe C and at the same time compressed air is delivered by the pipe D. The air, it is said, "whirls the concrete into confusion" so that its various ingredients do not separate out.—*February 17th*, 1927.

MISCELLANEOUS.

255,448. July 12th, 1926.—OIL GAS GENERATOR, Otto Misch, of No. 48, Friedrichstrasse, Frankfurt-on-the-Main, Germany.

The heat accumulator consists of a retort filled with coke, and it is heated from the outside to a sufficient temperature for the gasification and decomposition of tar and oil, the gas being partly used for heating the retort and partly as circulating gas, so that the retort is heated both externally and internally. Referring to the drawing, A is the hopper by which the oil gas retort B is filled, and which is heated on the outside by gas. Tar and oil are injected through the conduit D into the incandescent coke C, which forms the heat bearer. The tar and oil are gasified and decomposed and oil gas is produced in the well-known manner, E being the outlet for the oil gas. The coke C, together with the carbon residues of tar and oil, descend and reach the generator in their incandescent state. The coke C in the gene-



rator G is either transformed into poor or rich gas, and the gas is partly used for the outside heating of the retort and partly serves as circulating gas. H is the gas conduit for the outside heating.—*March 8th*, 1927.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Paper, "Internal-combustion Locomotives," by Lieut.-Colonel E. Kitson Clark. 6 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department of the University, St. George's-square, Sheffield. "Refined Silver for Electro-plating Anodes," by Mr. E. A. Smith. 7.30 p.m.

INSTITUTION OF NAVAL ARCHITECTS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Annual general meeting. For programme see page 336.

JOINT DELEGATION OF THE YORKSHIRE ASSOCIATIONS OF THE INSTITUTIONS OF CIVIL, MECHANICAL, ELECTRICAL, MUNICIPAL AND COUNTY, AND LOCOMOTIVE ENGINEERS.—Great Northern Hotel, Leeds. Second annual dinner. 6.30 for 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Electrical Osmosis," by Mr. E. Ambrose. 7.30 p.m.

PHYSICAL SOCIETY.—Imperial College of Science, South Kensington, S.W. 7. Papers, "A Carbon Dioxide Measuring Instrument Based on Sound-Velocity Measurement," by Dr. Ezer Griffiths; "The Scattering of X-Rays and the 'J' Phenomenon," by Mr. B. L. Worsnop; "The Characteristics of Thermionic Rectifiers," by Professor C. L. Fortescue. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Early Days in Radio Activity," by Sir Ernest Rutherford. 9 p.m.

WEST BROMWICH ENGINEERING SOCIETY.—Technical College, West Bromwich. Paper, "Electricity the Power of To-morrow," by Mr. G. S. Francis. 7.30 p.m.

SATURDAY, APRIL 9TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, JUNIOR SECTION.—College of Technology, Manchester. Annual general meeting. 6.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Luton Graduates' visit to the works of D. Napier and Son, Ltd., Acton Vale, London, W. 3.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the workshops and laboratory of S. G. Brown, Ltd., at Acton. 2.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Alpha Rays and Atomic Structure," by Sir Ernest Rutherford. 3 p.m.

MONDAY, APRIL 11TH.

BRADFORD ENGINEERING SOCIETY.—Technical College, Great Horton-road, Bradford. Annual general meeting. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Chamber of Commerce, New-street, Birmingham. Paper, "Nitro-Cellulose Enamels," by Mr. W. Fletcher-Starkey. 7 p.m.

RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Paper "The Importance of Secondary Train Services," by Mr. J. F. Gairns. 7.30 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, London, S.W. 1. Paper, "The Sugar Beet Industry in Great Britain," by Mr. G. T. Brown. 8 p.m.

TUESDAY, APRIL 12TH.

CRYSTAL PALACE SCHOOL OF PRACTICAL ENGINEERING.—London, S.E. 163rd Award of Certificates, by Mr. E. F. C. Trench. 3 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Burnley. Annual general meeting. 7.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, London, E. 1. Paper, "The Recovery and Utilisation of Heat from the Exhaust Gases of Marine Internal Combustion Engines," by Mr. T. Clarkson. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Further discussion on "The Enlargement of the City and South London Railway Tunnels," by Messrs. I. J. Jones and G. Curry. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, George-street, Glasgow. Paper, "The Application of Machinery at the Coal Face," by Mr. Sam Mavor. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Paper, "Latest Developments in Underfeed Stoker Practice in the United States," by Mr. J. G. Worker. 7.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. Paper, "The Carbonisation and Combustion of Particles of Coal. The Structure of Cenospheres," by Mr. F. S. Sinnatt. 4 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS: MIDDLESBROUGH BRANCH.—Cleveland Scientific and Technical Institution, Corporation-road, Middlesbrough. Lecture, "The Production and Modern Applications of Dissolved Acetylene," by Mr. W. C. Freeman. 7.30 p.m.

WEDNESDAY, APRIL 13TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—The University, Edmund-street, Birmingham. Paper, "The Applications of Electricity in Warships," by Mr. W. McClelland. 7 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, London, E.C. 4. Paper. "The Development of Power Transmission by Chain," by Mr. E. E. Bradbury. 7.30 p.m.

THURSDAY, APRIL 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. London Graduates' meeting. Paper, "Repairs," by Mr. W. G. Ruggins. 7.30 p.m.

FRIDAY, APRIL 22ND.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Informal meeting. "The Engineering of Distribution, with Special Reference to Finance as a form of Organisation," introduced by Major C. H. Douglas. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Shock Absorber Units for Land Planes," by Mr. C. D. Holland. 7.30 p.m.

SATURDAY, APRIL 23RD.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—County Hall, Ipswich. Eastern District meeting. 10.45 a.m.

MONDAY, APRIL 25TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Graduates' Section meeting. "Parcel and Package Conveying Plant," by Mr. H. W. Cadman. 7 p.m.

RAILWAY CLUB.—25, Tothill-street, London, S.W. 1. Debate, "That the Grouping of British Railways has not been Beneficial." 7.30 p.m.

THURSDAY, APRIL 28TH.

INSTITUTION OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, London, S.W. 1. Debate, "That the System of Education of Structural Engineers by Articled Pupilage is Contrary to the Best Interests of the Student, and should be Superseded by Education in Recognised Engineering Schools." 8 p.m.

FRIDAY, APRIL 29TH.

DIESEL ENGINE USERS ASSOCIATION.—Caxton Hall, Westminster, London, S.W. 1. Paper, "Further Developments in Mechanical Injection Oil Engines," by Mr. Oswald Wans.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Paper, "The Failure of Some Steel Wires Under Repeated Torsional Stresses at Various Mean Stresses," by Professor F. C. Lea and Mr. F. Heywood. 6 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. LOUGHNAN PENDRED is leaving at once for the United States and expects to be absent for about two months.

THE AGENCE HAVAS, Ltd., asks us to announce that it has changed its address from 6, Breams-buildings, E.C. 4, to Bank Buildings, 20, Kingsway, London, W.C. 2.

THE FARADAY SOCIETY asks us to announce that it has changed its address from 90, Great Russell-street, London, W.C. 1, to 13, South-square, Gray's Inn, London, W.C. 1. Telephone, Chancery 7230.

A.F.A. ACCUMULATORS, Ltd., of 120, Tottenham Court-road, London, W. 1, asks us to announce that it has been appointed sole concessionnaire in British territory of the D.E.A.C. nickel-steel accumulators, as made by the Deutsche Edison Accumulator Company.

MR. LIONEL ROBINSON, of 3, Staple Inn, London, W.C. 1, asks us to announce that he terminated his agreement with Henry Wiggin and Co., Ltd., as London manager on March 31st, and that he will now act as London consultant for them and will continue his business at Staple Inn.

ERRATUM.—In the letter under the heading "An Old Beam Engine," which was printed in our issue of April 1st, the name of the firm owning the engine was inadvertently given as Thos. Lenty and Co. It should have been Thos. Leuty and Co.

THE BRENFORCE TRAVELLING SCHOLARSHIP.—The Institution of Structural Engineers announces that the Brenforce Travelling Scholarship, which carries with it an award of £300 and a gold medal, and outline particulars of which were given on page 311 of our issue of March 18th last, will be competed for on May 7th, 1927. The closing date for entries is Monday, May 2nd.

MERCHANDISE MARKS ACT, 1926.—With reference to the announcement made in the Press on March 24th, the Standing Committee announces that it will begin the inquiry with regard to certain descriptions of imported iron and steel on Monday, April 25th, at 2 p.m., and, if necessary, will sit on the morning and afternoon of Tuesday and Wednesday, April 26th and 27th. The descriptions of iron and steel covered by the inquiry are as follows:—(1) The following descriptions of steel: Plates, rails, joists, angles, channels, sectional material of all descriptions, castings, forgings, rounds, squares, flats, hexagons, hoops, hot and cold rolled strip; (2) the following descriptions of wrought iron: bars, hoops, sections, plates and sheets. The sittings of the Committee, which will be open to the public, will be held in Room 74a, First Floor, New Public Offices, Great George-street, London, S.W. 1. Representatives of any interests substantially affected by the applications made for the purpose of requiring the above-mentioned classes and descriptions of goods to bear an indication of origin, who desire to be heard in opposition, are requested to communicate with the Secretary of the Committee, Mr. E. W. Reardon, at the New Public Offices, Great George-street, London, S.W. 1, with the least possible delay and, if practicable, not later than April 19th.